



Distribution, ecology & status of 51 macromycetes in Europe

Results of the ECCF Mapping Programme



Andre Fraliture and Peter Otto (eds)



Reading Room

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Summary

During the last years, a Mapping Programme has been launched by the European Council for the Conservation of Fungi (ECCF) to study the distribution of 51 species, as well as their ecology and status, on the European continent. The selected species belong to different groups of Ascomycetes and Basidiomycetes. Most of them are threatened in some way, at least in a region of Europe. A total of 38 countries participated in the study. In each country, a national coordinator collected all the available information, with the help of local mycologists, compiled it in a homogenous presentation and sent it to the two ECCF responsables of the project. In total, we can say that the results of the study have been produced thanks to the efforts of nearly 300 mycologists.

The difficulties encountered when mapping fungi are described: data must be gathered in the field, in herbaria, in the literature and in the unpublished notes kept by mycologists; collections must be properly identified and the exact coordinates of the growth places must be found. The differences between maps and actual distribution of the species are discussed. The phytogeographical zones used to interpret the distributions are presented (after Ozenda 1994).

The countries with the highest number of species are Germany and France (44 species on 51), Italy and Spain (43 sp.) and Poland (39 sp.). These good results are partly due to the mycological richness of these countries but also to the fact they possess a large territory and that they are rather well explored at a mycofloristic point of view. The species present in the highest number of countries are *Panaeolus semiovatus* (34 countries on 38), *Helvella atra* and *Sarcosphaera coronaria* (33 countries) and *Strobilomyces strobilaceus* (32 countries). At the other end of the list, the rarest species are *Tulostoma niveum* (4 countries), *Haploporus odorus* and *Torrendia pulchella* (5 countries) and *Antrodia albobrunnea*, *Cortinarius ionochlorus* and *Poronia erici* (8 countries).

The comparison between our maps and those published by Lange (1974) clearly shows an increase of the distribution area and the abundance of the species in 40 years. However, rather than being due to an expansion of the species, these changes are far more likely attributable to a more thorough exploration of the territory (40 years more !) and a better accessibility to data (computerized databases).

Comments are given to various distribution patterns. Some species follow rather faithfully their host-tree, others are more influenced by purely geographical factors (subboreal, southern, mountain and coastal species). Five species which seem to be bound to the Boreal domain are probably rather bound to old growth forests, which almost disappeared from the rest of Europe.

In the second part of the work, the distribution maps of the different species are presented (with distinction between data made before or from 1970), together with comments on the distribution (in the world and in Europe), ecology (trophism, host and substrates,

syntaxa of vegetation, Natura 2000 habitats, soil requirements, indicator value, phenology) and status (frequency, threats and conservation). Pictures of the species are also given. The work ends with a bibliography of nearly 600 titles.

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Introduction

Presentation of the project

Inception and history of the project

A study of this scale cannot be achieved in a short time. The heavier the machine, the more it is slow to start. It took 14 years to European mycologists to produce the 50 distribution maps published by Lange (1974). We report in the following lines the development of this ECCF Mapping Project, from its “prehistory” to the publication of the results.

The *European Committee on the Protection of Fungi* (ECPF) has been created during the 9th Congress of European Mycologists in Oslo (1985) and renamed subsequently *European Council for the Conservation of Fungi* (ECCF), during the 10th CEM in Tallin (1989). At the first Meeting of the ECPF in Łódź (Poland, 1988), the interest of initiating a program for mapping of a selection of (presumably) threatened macrofungi in Europe is already stressed (Arnolds & Jansen 1989, Arnolds 1990a, 1990b).

During the ECCF Meeting in Vilm (Germany, 1991), a discussion takes place about the necessity to obtain the inclusion of fungi in the Appendix I of the Bern Convention on the Conservation of European Wildlife and Natural Habitats (Pegler 1991). There is an agreement about the fact that included species should be endangered, represent a range of habitats, be spread throughout taxonomic groups, have visual appeal and be readily recognizable. A list of 10 species considered to have priority is proposed, together with a list of 25 additional species. It is also suggested to use the 50 × 50 km UTM grid (Parmasto 1991).

It started a long process of discussions about the feasibility of the project and about which species should be included in the list. During the ECCF Meeting in Vipiteno (Italy, 1997), a more concrete proposal is made, including a new list of 25 species (Otto & Ohe-noja 1998).

At the Meeting of Alcala de Henares (Spain, 1999), the project is officially adopted. A list of 50 species is accepted and P. Otto and A. Fraiture agree to be responsible of the project. But it is at the Meeting of Kuusamo, Oulanka (Finland, 2001) that the real start occurs. The instructions on how to present the data on distribution and how to report data on ecology and status are discussed and adopted (see the paragraphs on “Frame of the project”, hereunder). They are subsequently distributed to the national coordinators (see the paragraphs on “Organization”, hereunder), together with a list of the 50 species correct names and synonyms.

At the Meeting in Katsiveli (Ukraine, 2003), the contributions of 9 countries (Austria, Bulgaria, Spain, Italy, Latvia, Malta, Portugal, Romania and Serbia-Montenegro) are in the hands of the coordinators of the project. The other countries are asked to send their data as soon as possible.

At the Meeting in Cordoba (Spain, 2005), the first provisional maps are presented, includ-

ing data from 26 countries. By looking at the maps, it is obvious that numerous gaps and some errors still remain in the data. However, these maps stimulated the remaining countries to send their data and the other ones to propose additions and a few corrections.

Many additional data are sent to the ECCF coordinators and, at the St-Petersburg Meeting (Russia, 2007), a second version of the maps is shown, with the data from 36 countries. Only Ireland, Bosnia, Albania, Moldavia, Belarus, Cyprus and Kazakhstan are still missing.

A last attempt is then made to obtain the collaboration of the few still missing countries. At the same time, the maps are sent to the national coordinators, so that they can check them and send additions and corrections.

The “sub-final” version of the maps is presented at the Meeting in Halkidiki (Greece, 2011). It contains the data sent by 38 countries (Ireland and Cyprus joined the group). A draft version of the synthesis about ecology and status of the 51 species has been compiled by P. Otto.

Since then, the two coordinators worked on the draft, adding many data from literature and asking the national coordinators to complete the information concerning the ecology of the species. On this occasion, a last harvest of additions and corrections to the maps has also been made. An introduction has been written and the work has finally been published, thanks to a cooperation with the *Botanic garden Meise* (formerly *National botanic garden of Belgium*).

Frame of the project

The general purpose of the programme was to collect information about distribution, ecology and status of a series of fungal species, according to the following rules.

To be included in the list, the species had to:

- be a macromycete (microfungi have not been included because of our lack of knowledge about their distribution and status) (Otto & Ohenoja 1998),
- belong to different groups of Ascomycetes (Discomycetes, Pyrenomycetes) and Basidiomycetes (Agaricales, Boletales, Aphyllophorales, “Gasteromycetes”),
- be taxonomically well-defined,
- be relatively easy to identify,
- be threatened in several countries of Europe,
- represent different floristic regions, vegetation types and geographical distribution patterns in Europe,
- be present in the different regions of Europe (at least 2 species should occur in every participating country).

Other decisions were:

- The number of species to be included in the project had been fixed to 50. However, it was finally decided to consider *Poronia punctata* and *P. erici* as two independent species and the number of species became 51.
- The geographical limits of the study are those of the European continent. For Russia and Turkey, only the minor part of their territory situated in Europe is taken under consideration.
- The UTM system has been chosen, with the 50 × 50 km grid, but the national coordinators were free to send their data in another system of coordinates, such as Decimal

degrees (Greenwich), Degrees-minutes-seconds (Greenwich), Numeric UTM, Alphanumeric UTM (MGRS), Grades (Paris), British National Grid, Irish TM Grid, Lambert belge 1972 and IFBL (Institut de Floristique Belgo-Luxembourgeois).

- The distribution maps have been drawn by Yvan Barbier (DEMNA, Belgium), with the software “Carto Fauna-Flora” and “Data Fauna-Flora”, which he developed together with colleagues (Barbier & Rasmont 2000, Barbier et al. 2000).
- Each record must include the year of observation or, at least, mention if the observation was recorded up to 1969 or from 1970 onwards.
- Data concerning ecology and status of the species in the different countries must also be collected.

Organization

Finally, this study involves 38 of the 47 countries having at least a part of their territory within the limits of the European continent. The missing countries are Bosnia, Albania, Moldavia, Belarus and Kazakhstan, together with 4 small European states (Monaco, San Marino, Andorra and Vatican).

Each participating country designated a national coordinator, who worked in cooperation with local mycologists. For the total of the study, about 240 main contributors cooperated with the national coordinators (see the list on p. 27) so that the total number of people who took a significant part in the project approaches 300.

The national coordinators were in charge of organizing the collecting of information about the distribution, the ecology and the status of the 51 species in their country and of treating the results in order to obtain, for each species, a homogenous presentation of the data. These results were subsequently sent to the ECCF, where Peter Otto was responsible for the writing of a synthesis on the ecology and status of each of the 51 species in Europe, and André Fraiture for the realization of the European distribution maps of these same taxa.

The whole organization has been working without any funding.

Difficulties and problems encountered when mapping macromycetes

Observation of fungi in the field

Molecular techniques allow species identification on the basis of soil samples or mycelium fragments. However, there are still many species for which no sequence is available on GenBank. Furthermore, if these techniques can be used for studies in permanent plots, they are never implemented for floristic inventories and virtually all data on the distribution of macrofungi are obtained by the observation of fruitbodies.

This constraint leads to a difficulty because macromycetes fruit sporadically and sometimes not every year. Moreover, fruitbodies are usually fleeting, remaining observable 5 to 15 days only, in most cases. The fruitbodies of some species are even less resistant (e.g. *Coprinus* sp.); others, on the contrary, remain observable (e.g. some Gasteromycetes) or even alive (some polypores) for months or even years.

The identification of a species as well as the description of its ecology require time and experience. The results must also be registered to remain available.

Collecting, checking and compiling data

To draw the distribution map of a macromycete species in a country and to study its ecology and status is a hard task, because all the reliable data concerning the species must be included. Computerized databases are a great help and a growing number of mycologists, institutions, regions or countries are now digitalizing data about macromycetes. Despite that, in most countries, the largest part of the data still remains dispersed between a large number of sources of different nature. Public herbaria belonging to botanic gardens and universities as well as private herbaria must be consulted. A very large number of mycological publications must be screened, including “grey literature”. The abundant unpublished data kept by mycological laboratories and private mycologists can also be an interesting source of information.

Collecting the data is only the beginning of the work. Even if it would not be possible to check all the data, some control must be applied, at least for critical taxa or in case of suspicious data (wrong ecology, locality outside the distribution zone ...).

Then, given that coordinates are rarely indicated on the labels or in the publications, it is necessary to find them for very numerous data; this requires a long stay in the map room or on the Internet. Finally, when all the coordinates have been found, they can be used to draw the map of the macromycete in the country and the distribution can be analysed and commented.

If the task is so hard to obtain a national map of a single species, what about the work needed for 51 species? ... And what if those 51 species are supposed to be mapped at the European scale? It is the work which has been done in the frame of the “ECCTF mapping programme”, which also included a compilation of the data about ecology and status of the 51 species, collected in the different countries. A list of the main contributors to the collection of data is given on pages 27-32.

Finally, to obtain the European maps, it has been necessary to transfer to a single UTM grid the data which have been sent in various coordinate systems (UTM, degrees minutes seconds, decimal degrees, British grid, IFBL ...) or as dots on printed maps.

Errare humanum est

As in any work and despite the controls which were made at different stages of this study, the presence of some errors remains very likely. They can mainly come from three sources. The first one is specimen misidentification. It was of course not possible to revise all the specimens included in the study and, moreover, all the data are not attested by a specimen. However, almost all the 51 species chosen for this study are relatively easy to identify and none of them are critical. A list has also been distributed to all the national coordinators giving, for every species, the correct name, the main synonyms and a few notes, in order to avoid any wrong interpretation of the species names. We therefore assume that misidentifications are rare in the data used.

A second source of errors lies in the calculation of the coordinates of the sites. A quick checking of the coordinates was systematically made, especially for the data transmitted by the national coordinators in an electronic file (mainly correction of the coordinates situated outside the borders of the country). Another control was made by the examination of the

maps: some points seemed doubtful because the dot fell clearly outside the distribution area of the species or out of the normal ecology of the species (e.g.: species supposed to grow next to the sea and mentioned at more than 500 km away from the sea, boreal species mentioned in a Mediterranean country).

Mistakes made during data transfer (coordinate conversion, manual addition of dots on the maps ...) are a third source of errors. Several careful controls have been made in this regard and there should be few such errors or even none.

Every time doubtful identifications or coordinates were noticed, the national coordinator concerned was asked to make the necessary checks and to confirm, correct or delete these data.

Distribution maps versus actual distribution of the species

Would all the data used in this work be perfectly accurate, the maps would still not represent exactly the present distribution of the species in Europe. Two factors should be stressed at that point of view. First of all, a map shows all the places where the fungus has been observed (at least if these observations have been communicated), but the species is probably no longer present in a certain number of these growth places.

On the other hand, it is certain that the mapped species are present in many places not represented on the maps. Growth places which have not been recorded will of course not be included in the mapping process. So, the more intense the field survey has been, the more accurate the maps will be. The intensity of the survey depends on the accessibility of the sites (topography, density of the road system, climate) and on the density and the activity of mycologists in the region. Inventories are obviously easier in countries which are small-sized, densely populated and benefiting from a temperate climate (ex.: Belgium, Netherlands) than in very big countries with a low density of population and a harsh climate. The best example of this latter case is certainly Russia. Under-exploration of the Russian territory is the main reason why species present in Boreal and Sarmatic domains usually seem almost absent from the Russian part of these domains. For instance, old-growth forest polypores are much more common in Russia than what appears from the maps (H. Kotiranta, pers. comm.).

It should also be noted that the number of dots on a map is often lower than the number of data collected for the species. A single dot may represent a series of successive observations at the same location or many observations of the species at various places (one dot on our maps covers an area of 2500 km²!).

Phytogeographical zones (after Ozenda 1994)

It is often assumed that fungi have a larger distribution area than higher plants, due to their wider ecology and to the higher dispersion potential of spores compared with seeds. It seems however that this principle is only valid for species having a wide ecology. Fungi living on a narrow range of hosts or substratum usually have a narrower distribution area than their hosts / substrate (e.g. *Pycnoporus cinnabarinus* and *Xerocomus parasiticus*, see Hansen & Lange 1966: 49).

Due to their heterotrophic way of life, a very large proportion of fungi are bound to vascular plants, which they use either as hosts or as substrates (there are some excep-

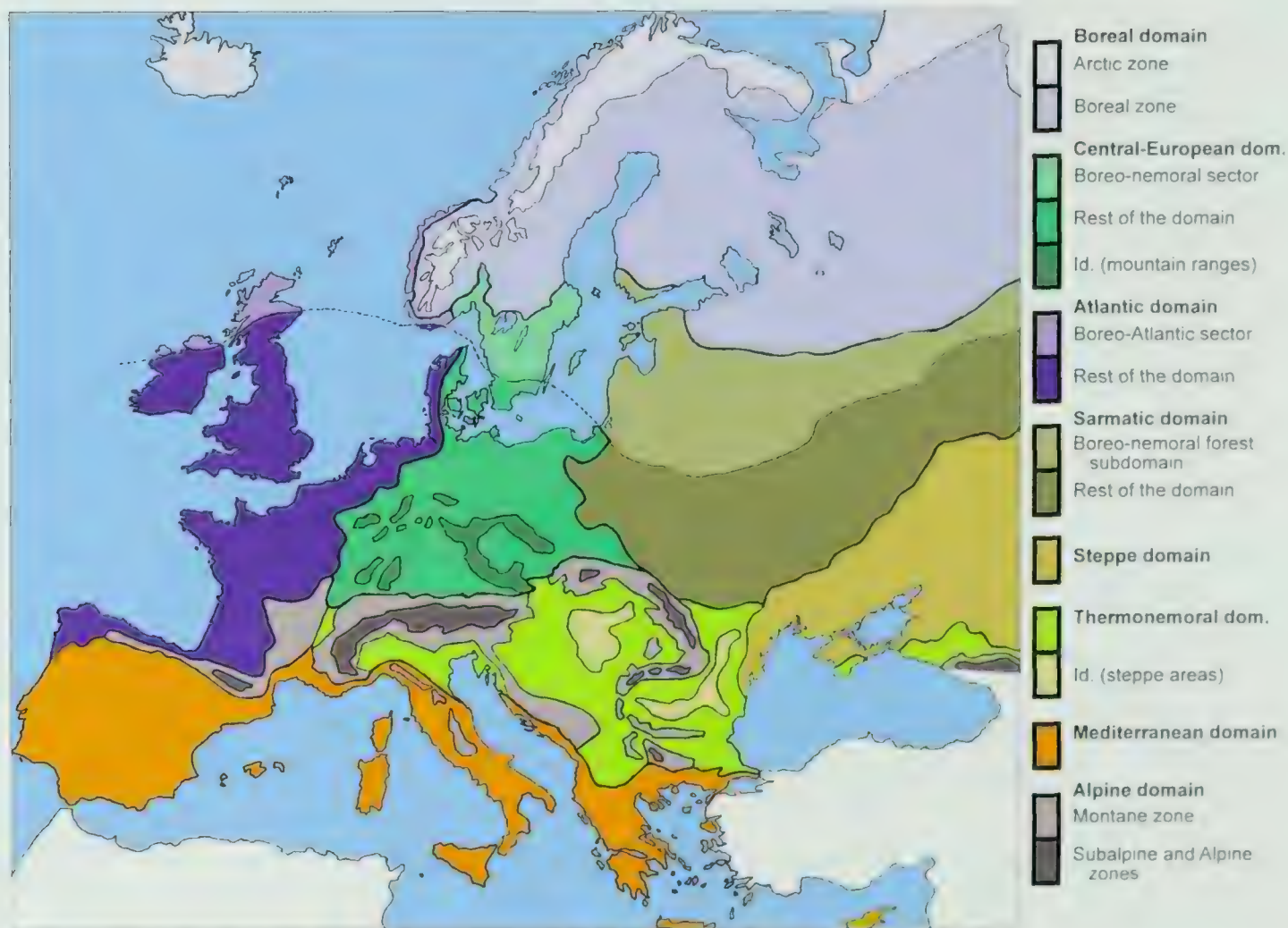


Figure 1. Phytogeographical regions of the European continent (after Ozenda 1994, modified).

tions among macromycetes: e.g. coprophilous, entomogenous, bryophilous, lichenicolous and fungicolous fungi). Consequently, it seems appropriate to use, for the interpretation of macromycetes distribution, the phytogeographical territories which have been delimited to figure the distribution of higher plants. The biogeographical theories published by Meusel et al. (1965), Holub & Jirásek (1967, 1968) and Walter & Straka (1970) can be used to express the distribution of fungi (Kalamees 1978). We chose to follow the work of Ozenda (1994), which is more recent and which also presents a more detailed biogeographical map of Europe. The limits of the phytogeographical territories proposed in that work correspond generally well with the divisions given by aforementioned authors and also by Knudsen & Vesterholt (2012: 32-34). The map presented at figure 1 shows the limits between the domains proposed by Ozenda (1994). The reader will find a much more detailed map in that book, as well as abundant comments and a large documentation on the plant geography of Europe. We give hereunder a survey of the phytogeographical zones proposed by Ozenda (1994).

Boreal domain (Arct. and Bor.) – In the Ozenda conception, the Boreal domain includes the Arctic zone (Arct.), which corresponds to the territories covered by tundra. Besides the northernmost part of Fennoscandia and Russia (Arctic tundra), which are classically considered as Arctic territories, it encompasses regions which constitute a transition to the taigas of the Boreal zone: subarctic tundra as well as mountain tundra which are occupying

the North of Ural and the mountainous regions of Sweden and Norway. The living conditions in the Arctic zone are very hard: very short growing season (2-3 months), permanent night in winter, low temperature (mean temperature of the warmest month: 5-10 °C), low rainfall (usually 200-300 mm/year), permafrost.

The rest of the domain constitutes the Boreal zone (Bor.). It is covered by a very large coniferous forest (taiga). The floristic composition is very poor because these forests are quite recent, having had to reinstall after the last glaciations. Trees are mainly represented by *Pinus sylvestris* and *Picea abies*. The living conditions are still hard. The average annual temperature remains below 0 °C but 100-200 days have a mean temperature above 5 °C, including 60-120 days above 10 °C and the warmest month above 15 °C. Rainfall is higher (500-800 mm/year) and evaporation remains low.

Three main subdivisions can be distinguished: In the north, the forest is mainly constituted by *Pinus sylvestris* and *Betula pubescens*. The center is the optimum of *Picea abies*. In the south, taigas have their vegetation gradually supplemented by various deciduous trees, initiating the transition to the Sarmatic and Central European domains. The limit between these two domains and the Boreal zone has been called “Limes Norlandicus”. It corresponds with 125 days with snow cover and 165 days with frost (Lange 1974: 43). In the east of the Boreal zone, as we approach the Ural Mountains, several species of Siberian conifers gradually appear (*Picea obovata*, *Pinus sibirica*, *Abies sibirica*, *Larix sibirica*). As usual, phytogeographical limits are perturbed by the presence of mountains and the subdivisions cited above are also present in the layering of the vegetation in the Scandinavian mountains. For a thorough discussion on boreal climatic-phytogeographical regions, see also Tuhkanen (1984) and Hämet-Ahti (1981).

Sarmatic domain (Sarm.) – This is the prolongation to the east of the Central European domain, but it has an even more pronounced continental character. From north to south, it can be divided into three sub-domains. The Boreo-nemoral forest subdomain (homolog of the Boreo-nemoral sector of the Central European domain, except that *Fagus* is here absent) covers most of the Baltic countries, the extreme north-eastern Poland (e.g. Białowieża forest), northern Belarus and a band of Russian territory along the Boreal zone. The Nemoral forest subdomain covers eastern Poland, southern Belarus, northern and western Ukraine and a band of Russia passing over Tula and ending in Kazan. The Wooded steppe subdomain corresponds to central Ukraine and a band of Russia going from Kursk to the Ural Mountains. It is a mosaic of steppes and forests, making the transition with the Steppe domain.

Atlantic domain (Atl.) – It includes British Isles, the coast of southern Norway, western Denmark and western Germany, the Netherlands, northern Belgium, the western half of France and the coast of northern Spain. The climate of these regions is strongly influenced by the proximity of the sea (Gulf Stream), which buffers temperature changes. Three main subdivisions can be distinguished, mainly based on the average annual temperatures. The Boreo-Atlantic sector (7-9 °C) covers northern Scotland and northernmost Ireland. It is homolog of the Boreo-nemoral sector of the Central European domain. The vegetation is mainly composed of Scots pine (*Pinus sylvestris*) forests, heaths and peat bogs. The Mediterranean sector (9-12 °C) occupies the rest of the Atlantic domain, except south-west-

ern France and Spain. It is mainly covered by deciduous forests (*Quercus*, *Fagus*). The Thermo-Atlantic sector (12-14 °C) covers SW France and the coast of northern Spain: oaks (*Quercus* spp.) are dominant in the forests, except for the large plantations of *Pinus pinaster* in the “Landes” region (France).

Central-European domain (C-Eur.) – It is located south of the Boreal zone, below Sweden and Norway. Beech (*Fagus sylvatica*) is here the dominant tree species. Several subdivisions are distinguished by Ozenda. The northernmost one is the Boreo-nemoral sector, which occupies southern Sweden (except Scania) and the coasts of southern Norway and makes the transition with the Boreal zone. The second one is the Baltic *Fagus* forests sector. It is present in southernmost Sweden (Scania), eastern Denmark and the coastal regions of Poland and eastern Germany. The southern half of the Central European domain is divided between Subcontinental sector (in the east: eastern Germany, western Poland, Czech Republic), with more continental influences, and the Subatlantic *Quercus-Fagus* forests sector (in the west: southern Belgium, north-eastern France, western Germany). Within the two last sectors, limits are perturbed by the presence of several mountain ranges (Vosges, Belgian Ardenne and Mittelgebirge).

Alpine domain (Alp.) – It includes the mountainous regions of southern Europe: Pyrenees, Alps, Carpathians and mountains of lesser importance, such as the French Vosges and Massif Central, and the Balkan mountains. The vegetation shows similarities with the Boreal zone and the Boreo-nemoral sector. Traditionally, different successive life zones are distinguished from bottom to top: montane zone (mainly *Fagus* and *Abies* forests), subalpine zone (*Larix*, *Pinus uncinata*, *P. mugo* and *P. cembra*), alpine zone (above the potential limit of the trees) and snow zone (higher plants virtually absent).

Thermonemoral domain (Therm.) – It makes the transition from the forests of the Central European and Sarmatic domains to the Mediterranean domain. The difference is mainly marked by the presence or the dominance of thermophilic species (mediterranean *Quercus*, *Pinus*...). The Thermonemoral domain includes the Po valley, the Pannonian depression, north-eastern Balkans and the foothills of the Caucasian chain. A part of that territory (centre of the Pannonian depression, lower Danube and Thrace) is covered by steppes, which are homologous of the Steppe domain. The surface of the Thermonemoral domain is reduced by the presence of several mountainous areas, belonging to the Alpine domain (Dinaric Alps, Balkan Mountains, Rhodope Mountains, etc.).

Mediterranean domain (Medit.) – This domain occupies the southernmost part of the European continent. It is characterized by high temperatures (the mean temperature of the coldest month is above 3-10 °C, except on the higher elevations) and dry summers, with very scarce rainfall and high evaporation, due to high temperature. The vegetation is mainly composed of thermophilic species, which are resistant to high temperatures and summer drought, but require mild winters. Three zones can be distinguished in the Mediterranean domain. The Submediterranean zone is the transition to the Atlantic and Thermonemoral domains. It is the only zone of the Mediterranean domain where the olive tree (*Olea europaea*) is not grown. The Thermomediterranean zone, on the contrary, occupies the lowlands, especially along the coasts of the southern Mediterranean countries (Spain, Italy,

Greece and Cyprus). The temperature is high, with an annual average of 16-21 ° C. The Mesomediterranean zone is situated between the two other zones of the Mediterranean domain. Forests are dominated by *Quercus ilex* and *Q. suber*. Their degradation gives rise to scrublands (“matorral” in Spain, “maquis” and “garrigues” in France). As already observed in other domains, the limits between the different zones are perturbed by the presence of mountains and the three zones can be present at various elevations on the same mountain.

Steppe domain (Step.) – This domain occupies the greater part of the Romanian coast, southern Ukraine and southern Russia, with the exception of the Caucasus region. It is covered by a vegetation mainly composed of Poaceae and practically devoid of trees (steppe). Rainfall is low and decrease gradually from the boundary with the wooded steppes of the Sarmatic domain (500 mm / year) to the Caspian Sea (150 mm / year). Soils are mostly chernozem, which are very fertile and composed of loess covered by a thick humus layer.

Analysis of the results

Variability between countries

One of the first observations which can be made, when analysing the data, is that there is a large diversity between the different countries in the state of progress of the floristic inventories. The fact was already stressed by Lange (1974). The map presented at figure 2 shows the number of species reported in each of the squares. Diversity between countries is clearly visible but some comments must be made. First of all, it has already been said that that kind of map mainly represents the distribution of the mycologists and of their favourite sites of prospecting. It is easy to see on the map the influence of big cities and mycological centres such as Bilbao, Barcelona, Sienna, Paris, London, Edinburgh, Oslo, Stockholm, Helsinki, ... Second, the map contains only the data of 51 species, the area of which is not evenly distributed on the European territory. Third, the map contains only the data which have been transmitted. In underexplored territories, this number is certainly much lower than what it could be with a more thorough exploration. For all those reasons, it should be stressed that this map is definitely not an accurate picture of the mycological richness of the different countries.

In a still quite restricted group of countries (but their number is growing), macromycetes inventory is well advanced and the process of encoding all floristic data in a common database is almost achieved. For those countries (Austria, Denmark, Finland, Netherlands, Norway, Sweden, Switzerland, UK and perhaps a few others) it was easy to select and to send the data and a large number of reports was usually transmitted (788 to 4235 data per country). Many other countries have not yet reached this “ideal”, either because the mycofloristic exploration of their territory is still incomplete or because the introduction of the collected information in a common database is not realized yet. However, the situation continues to improve constantly at that point of view.

Presence of the species in the different countries

Table 1 gives the presence or absence of the 51 species in each of the participating countries. The number of observed species varies considerably from country to country and

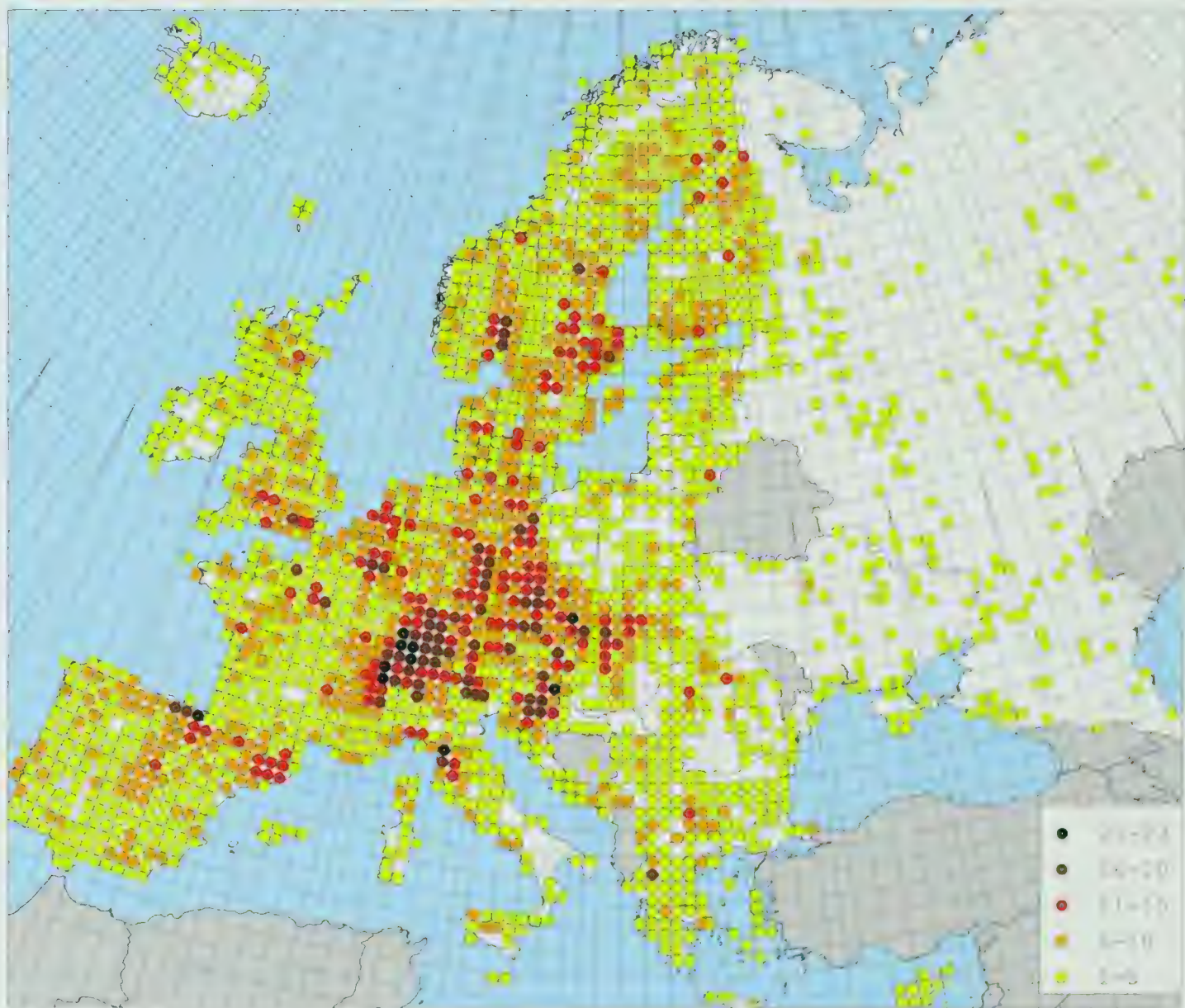


Figure 2. Cumulative map showing how many of the 51 species have been found in each square of the grid

goes from 4 to 44 (mean = 26 species/country). The countries with the highest number of species are Germany and France (44 species), Italy and Spain (43 sp.) and Poland (39 sp.). In this instance, their leading position is quite natural because they possess a large territory and they are also rather well explored at a mycofloristic point of view. At the other end of the scale, we find countries with very small territories, such as Malta (4 sp.), Cyprus (9 sp.) and Luxemburg (12 sp.), a country with rather extreme climatic conditions in which many of the 51 species cannot live (Iceland, 6 sp.) and a country which probably remains rather under-explored (Rep. of Ireland, 12 sp.).

Conversely, it is possible to compare the number of countries in which each species has been observed. The most widely distributed species are *Panacolus semiovatus* (34 countries), *Helvella utra* and *Sarcosphaera coronaria* (33 countries) and *Strobilomyces strobilaceus* (32 countries). At the other end of the list, the rarest species are *Tulostoma niveum* (4 countries), *Haploporus odoratus* and *Torrencia pulchella* (5 countries) and *Antrodia albobrunnea*, *Cortinarius ionochlorus* and *Poronia erici* (8 countries). These rare species usually have stricter ecological requirements, what strongly limits the number of habitats in which they can develop.

	Austria	Belgium	Bulgaria	Croatia	Cyprus	Czech Rep.	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Iceland	Rep. Ireland	Italy	Latvia	Liechtenstein	Lithuania	Luxemburg	Macedonia	Malta	Montenegro	Netherlands	Norway	Poland	Portugal	Romania	Russia (Eur.)	Serbia	Slovakia	Slovenia	Spain	Sweden	Switzerland	Turkey (Eur.)	UK	Ukraine	Countries/sp.					
Amanita caesarea	x	x	x	x	.	x	.	.	.	.	x	x	x	.	.	x	.	.	.	.	x	.	x	.	.	x	x	x	x	x	x	x	x	.	x	x	.	x	.	23				
Amanita friabilis	x	x	.	.	.	x	.	x	x	x	x	.	x	.	.	x	x	.	.	.	.	.	.	x	x	x	x	.	x	.	x	x	x	x	x	.	x	.	.	22				
Amylocystis lapponica	.	.	x	x	.	x	.	x	x	.	.	.	.	.	.	x	.	.	.	.	.	.	.	.	.	x	x	.	.	x	.	x	.	.	.	.	.	.	.	x	12			
Antrodia albobrunnea	.	.	.	.	.	.	.	.	x	.	.	.	.	.	.	x	.	.	.	.	.	.	.	.	.	x	x	.	.	x	.	.	.	x	x	.	.	.	.	8				
Armillaria ectypa	x	x	.	.	.	x	x	.	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	x	.	x	.	.	x	.	.	.	.	.	.	.	.	.	x	13			
Bankera fuligineo-alba	x	x	.	.	.	x	x	x	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	x	21			
Battarea phalloides	x	x	x	.	x	x	.	.	.	x	x	x	x	.	.	x	.	.	.	.	x	.	.	.	.	.	x	.	x	x	x	.	.	.	.	.	.	.	.	x	x	20		
Boletopsis grisea	x	.	.	x	x	x	x	x	x	x	x	x	.	.	.	x	.	.	.	.	.	.	x	.	.	x	x	.	.	x	.	x	x	x	x	.	.	.	.	.	20			
Boletus dupainii	x	.	x	x	.	.	.	.	.	.	x	x	x	.	.	.	.	.	.	.	x	.	.	.	.	.	x	.	.	x	x	x	x	x	.	.	.	.	.	15				
Bovista paludosa	x	.	.	.	.	x	.	x	x	x	x	.	.	.	.	.	.	.	x	.	.	.	.	x	.	x	x	.	.	.	.	.	.	.	.	.	.	.	.	x	18			
Cortinarius ionochlorus	.	x	.	x	.	x	.	.	.	.	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8			
Craterellus melanoxeros	x	x	.	.	.	.	.	x	x	x	x	x	x	.	x	x	.	.	.	x	.	.	.	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	x	23			
Entoloma bloxamii	x	x	.	x	x	x	x	x	.	.	x	x	x	.	.	x	.	.	.	x	.	.	.	.	.	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	x	27		
Faerberia carbonaria	x	x	x	x	.	x	x	.	.	.	.	x	x	x	.	.	.	.	.	.	.	.	.	.	.	x	.	x	x	.	.	.	.	.	.	.	.	.	.	.	x	x	25	
Gomphus clavatus	x	.	x	.	.	x	x	x	x	x	x	x	x	.	.	.	x	x	x	x	.	.	.	x	.	x	x	x	x	x	x	x	x	x	x	.	.	.	.	.	x	x	29	
Hapalopilus croceus	x	x	x	x	.	x	x	x	x	x	x	x	x	.	.	.	x	x	.	.	.	.	.	.	.	x	x	x	x	x	.	.	.	.	.	.	.	.	.	.	.	x	26	
Haploporus odorus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5		
Helvella atra	x	x	x	x	.	x	x	x	x	x	x	x	x	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	x	33	
Hericium erinaceus	x	x	x	x	.	x	x	.	.	.	.	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	x	29	
Hohenbuehelia culmicola	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	x	10	
Hydnellum suaveolens	x	x	x	.	.	x	.	.	x	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	x	25	
Hygrocybe calyptriformis	x	x	.	x	.	x	x	.	.	.	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	x	26	
Hygrocybe laeta	x	x	x	x	.	x	x	.	.	.	.	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	x	26	
Hygrophorus marzuolus	x	x	x	x	.	x	.	.	.	.	.	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	
Hygrophorus purpurascens	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14	
Hymenochaete cruenta	x	x	x	x	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	23	
Laccaria maritima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	
Laricifomes officinalis	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15	
Leucopaxillus tricolor	x	x	x	x	.	x	x	.	.	.	.	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	25	
Lyophyllum favrei	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	
Montagnea radiosa	x	.	.	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13	
Myriostoma coliforme	x	x	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	25	
Panaeolus semiovatus	x	x	x	x	.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	34	
Phylloporus pelletieri	x	x	x	x	.	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	31	
Pisolithus arrhizus	x	x	x	x	x	x	x	x	x	x	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	31	
Podoscypha multizonata	.	.	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	
Polyporus rhizophilus	x	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13	
Poronia erici	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	
Poronia punctata	.	.	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	31	
Pycnoporellus alboluteus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	
Sarcodon fuligineoviolaceus	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15	
Sarcosoma globosum	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14	
Sarcosphaera coronaria	x	x	x	x	x	x	x	x	x	x	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	33	
Skeletocutis odora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	16
Strobilomyces strobilaceus	x	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	32	
Suillus flavidus	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26
Suillus sibiricus	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13	
Thuemenidium atropurpureum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	
Torrencia pulchella	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	
Tricholoma colossus	x	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26
Tulostoma niveum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Nbr. species/country	36	32	26	25	9	37	25	24	28	44	44	24	26	6	12	43	14	17	18	12	15	4	14	27	33	39	21	26	35	19	37	30	43	36	38	10	30	29						

Table 1. Presence of the different species in each country.

Comparison with the maps published by Lange

Distribution maps of a series of macromycetes at the European level have already been published. During the 2nd Mycological congress in Praha (1960), a steering committee was constituted which had the mission to choose a list of 100 European macromycetes. These species were supposed to belong to different systematic groups and to include some species occurring mainly in the xerothermic regions and in the arctic-alpine regions of the continent, together with others known to be confined to a specific host or substrate. After discussion, the committee adopted a list of species and promoted the collection of data concerning their distribution in Europe. Two first maps were published a few years later

(Hansen & Lange 1966), with some comments. The commented maps of the 50 first species were published by Lene Lange (1974). As far as we know, the maps of the 50 remaining species have never been published. Reid (1975) emitted some criticism on the work published by Lange, both about the method used and about the part of the maps which concerns Great Britain.

Lange (1974) discusses the advantages and disadvantages of different grid systems. He comes to the conclusion that the UTM-type is most likely the grid system which will be used in future cartographic work. He also says the size of the dots used on his maps is too small. The diameter of the dots on our maps (50 km) is about twice the one used by Lange and we consider it is perhaps a bit too large.

Ten of “our” 51 species had already been mapped by Lange (1974): *Sarcosoma globosum* (fig. 3), *Hymenochaete cruenta* (fig. 8, sub *H. mougeotii*), *Gomphus clavatus* (fig. 10), *Strobilomyces strobilaceus* (fig. 18, sub *S. floccopus*), *Suillus flavidus* (fig. 21), *Phylloporus pelletieri* (fig. 24, sub *Ph. rhodoxanthus*), *Hygrophorus marzuolus* (fig. 25), *Amanita caesarea* (fig. 33), *Panaeolus semiovatus* (fig. 42, sub *Anellaria semiovata*), *Pisolithus arrhizus* (fig. 46, sub *P. tinctorius*). At first glance, the comparison between these maps and the maps presented here seems to show that the abundance and the distribution area of the species increased in 40 years, sometimes in a very marked way. However, rather than being due to an expansion of the species – e.g. as a consequence of global warming –, these changes are far more likely attributable to “technical” factors such as a more thorough exploration of the territory, due to the longer period of observation (40 years more !), and a better accessibility to data (computerized databases). Additionally, there is a bias or artefact due to the fact that a dot covers a surface four times as big on our maps as on those of Lange.

These differences between “old and new” maps varies according to the geographic region. A careful examination of the different maps reveals that:

- A few regions were already very well explored 40 years ago. It is especially the case of former Czechoslovakia, Poland, Austria, UK, Denmark and the southern part of Fennoscandia. In these regions, the differences with the recent maps are not very important.
- Many other countries were rather well explored (Germany, Slovenia, Croatia, Romania...) and others rather poorly explored. The increase in the number of data is particularly spectacular for France, Switzerland and Greece.
- In addition, many countries did not participate in the first study while they are involved in this work (Portugal, Spain, Italy, Malta, Cyprus, Turkey (European part), Ukraine, Russia (European part), Lithuania, Latvia and Estonia). It greatly increases the surface area covered by the maps, which is 10,000,000 km² in the present work, while it was only about 4,000,000 km² on the maps published by Lange (1974).

Besides the “new dots” appeared on our maps, there are some dots which, on the contrary, are present on the maps of Lange and absent from ours. In a few cases, it could be due to misidentifications or wrong calculation of the coordinates, which were subsequently corrected, but more likely these collections have been overlooked during the second mapping programme.

Comments about some distribution patterns

A review of the maps presented in this work reveals a large diversity in the distribution patterns: e.g. northern versus southern species, continental versus coastal species. We give hereunder some comments on the subject. A discussion about distribution types of European macromycetes is also made by Lange (1974: 46-48) but it is focused on the northern limit of the areas.

The distribution of several species obviously corresponds with that of their host plant:

- *Suillus sibiricus* follows *Pinus cembra* in the Alps, Tatra Mountains and Carpathians, and *Pinus peuce* in the mountains of the Balkan Peninsula (pp. 108-109).
- *Laricifomes officinalis* follows *Larix decidua* (pp. 170-171).
- *Hymenochaete cruenta* follows *Abies alba* (pp. 180-181).
- *Bankera fuligineo-alba* (p. 188), *Boletopsis grisea* (p. 185) and *Suillus flavidus* (p. 105) have their distribution included in the very large area covered by *Pinus sylvestris* in Europe (see figs. 3 and 4).
- *Hydnellum suaveolens* (p. 192), *Sarcosoma globosum* (p. 203), *Hygrophorus purpurascens* (p. 89), *Amylocystis lapponica* (p. 164) and *Skeletocutis odora* (p. 160) have their area included in the distribution of their main host, *Picea abies* (see figs. 5 and 6).

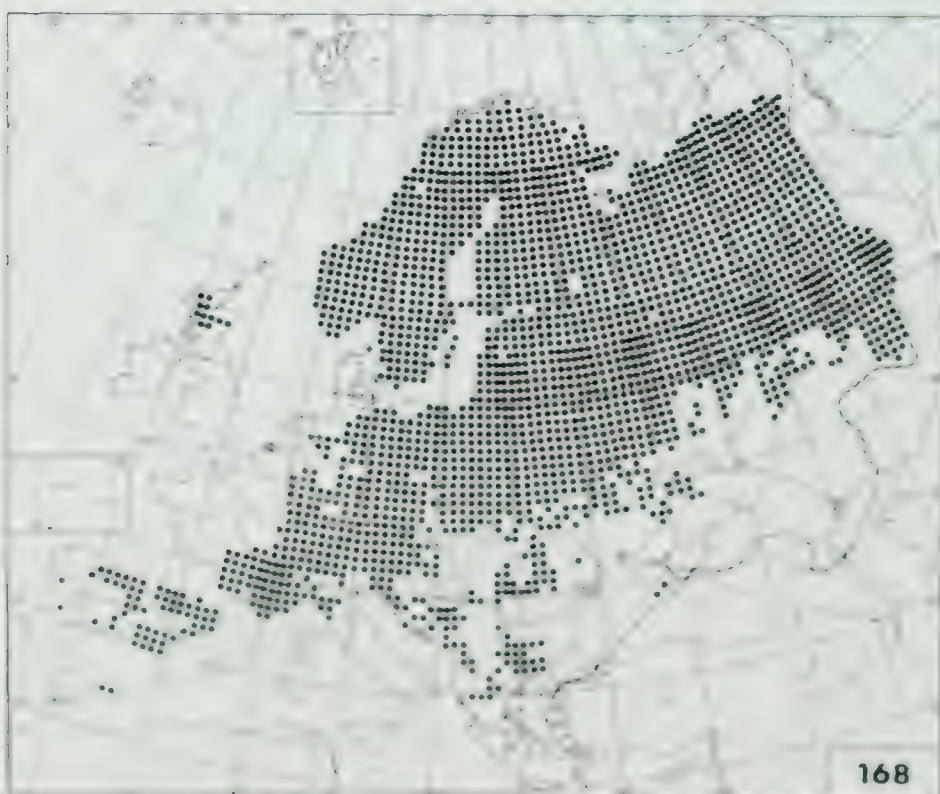
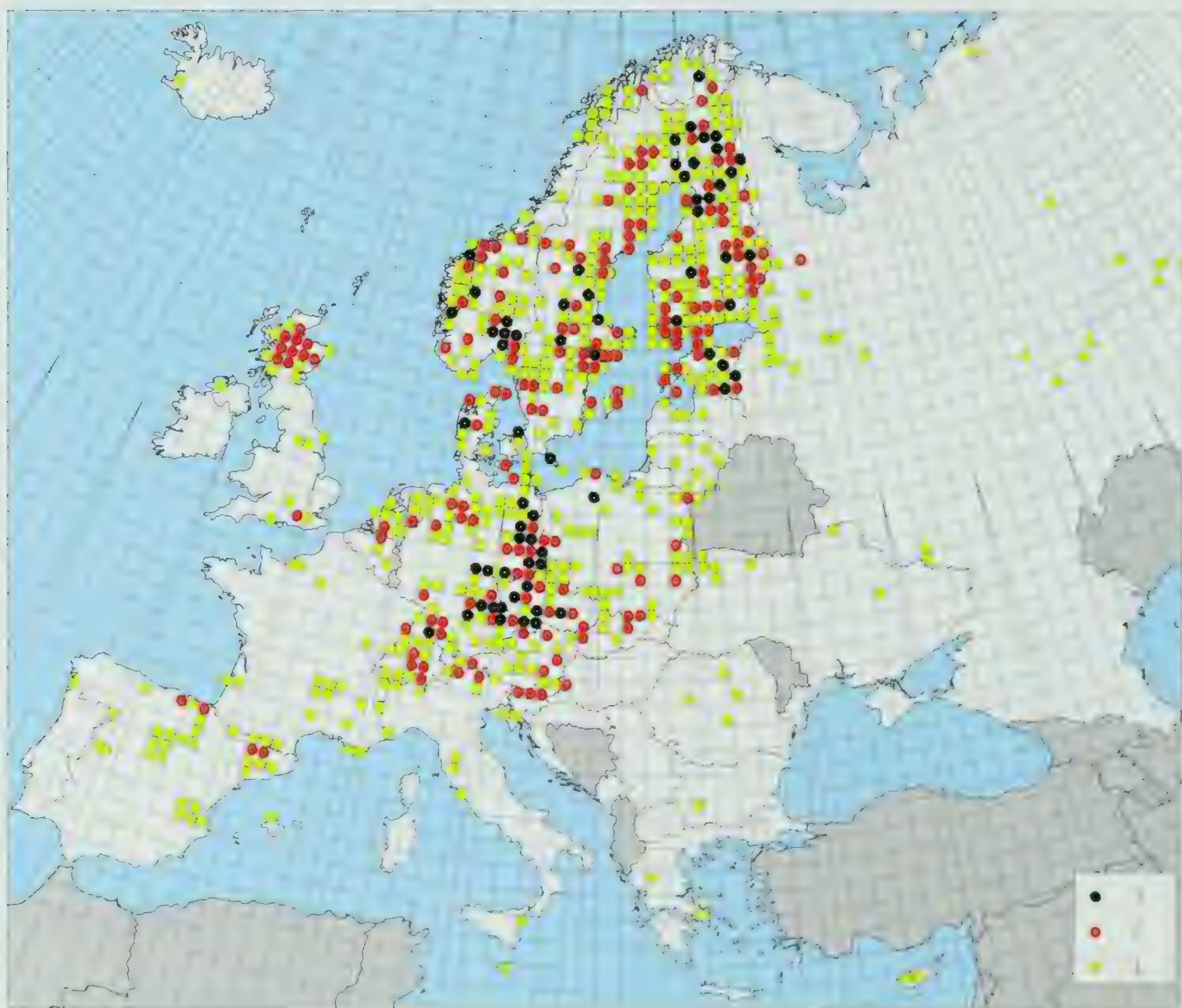
The following five species are not particularly bound with *Fagus* (except for *Phylloporus*) but their area corresponds fairly well with the distribution of that tree: *Faerberia carbonaria* (p. 145), *Hericium erinaceus* (p. 199), *Leucopaxillus tricolor* (p. 55), *Strobilomyces strobilaceus* (p. 98) and *Phylloporus pelletieri* (p. 92) (see figs. 7 and 8).

Some other species seem to have their distribution more influenced by purely geographical factors. Several examples are given hereafter.

“Boreal” species. The case of the following five polypore species is interesting.

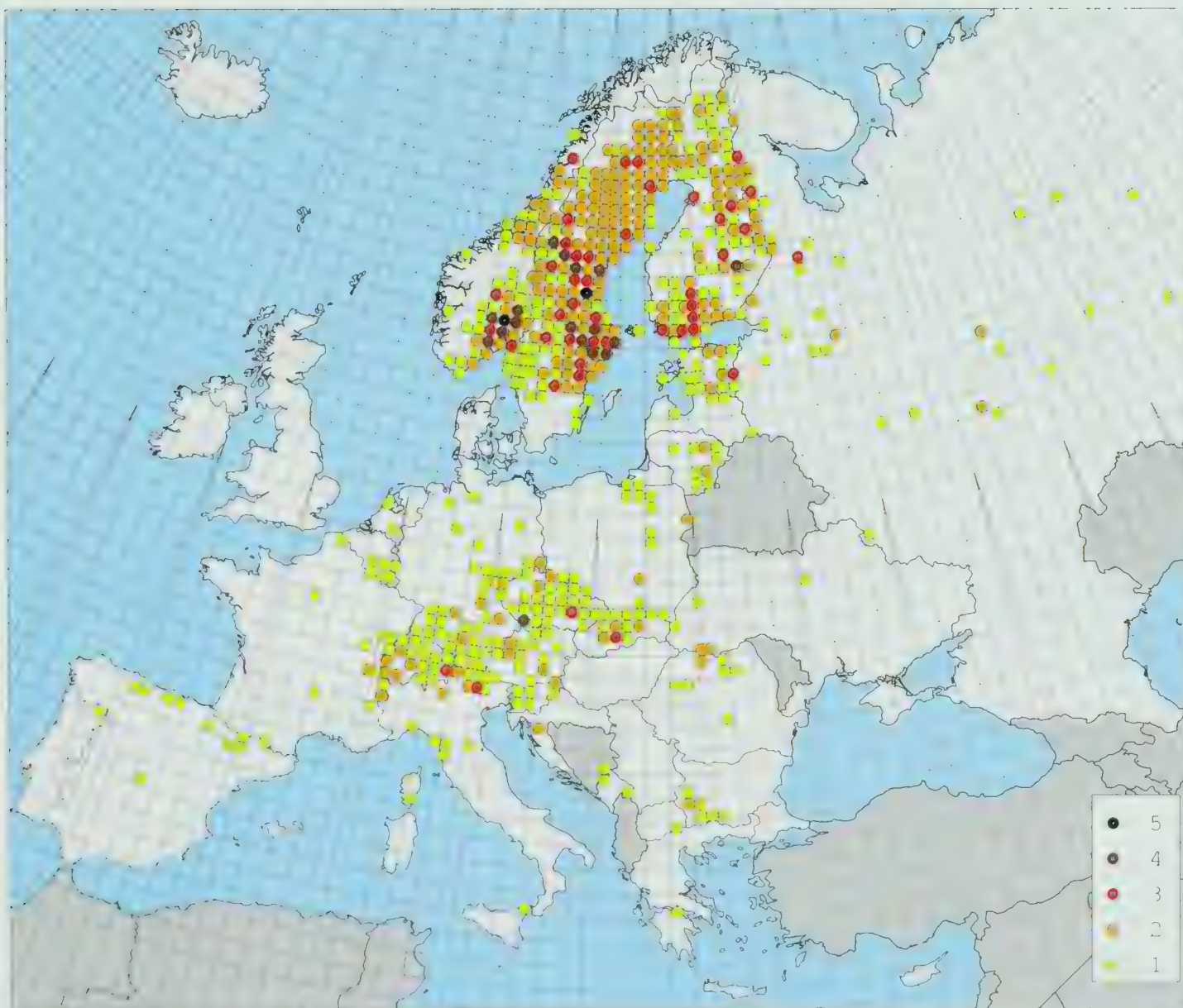
- *Amylocystis lapponica* (p. 164) lives on *Picea abies*,
- *Antrodia albobrunnea* (p. 168) is connected with *Pinus sylvestris*,
- *Haploporus odoratus* (p. 152) is associated with *Salix caprea* (p. 152),
- *Pycnoporellus alboluteus* (p. 175) is mostly bound to *Picea abies*, rarely to *Abies* and
- *Skeletocutis odora* (p. 160) mainly lives on *Picea abies*, rarely on *Pinus sylvestris* and *Abies*.

All host plants cited for these five polypores have a very wide distribution in Europe whereas the distribution of these fungi is remarkably smaller and almost restricted to the Boreal domain (see fig. 9). One could thus be tempted to conclude that these five species have particular affinities for high latitudes. It is possible but one should take notice that scattered observations of the five polypores have been made everywhere in Europe, even in the Mediterranean domain. It should also be stressed that all the five species are known to grow very preferentially in old growth forests. *Antrodia albobrunnea* is even cited by Niemelä et al. (2002) among the “kelo fungi” [“kelo” is a Finnish term to design *Pinus sylvestris* trees which, after reaching the age of 300-500 years, died and remained standing in the forest for another 200-500 years or even more]. So, the conclusion should probably be that these polypore species are in fact bound with very old trees in old growth forests and that they are now almost restricted to the Boreal domain because old growth forests almost disappeared from the rest of Europe.



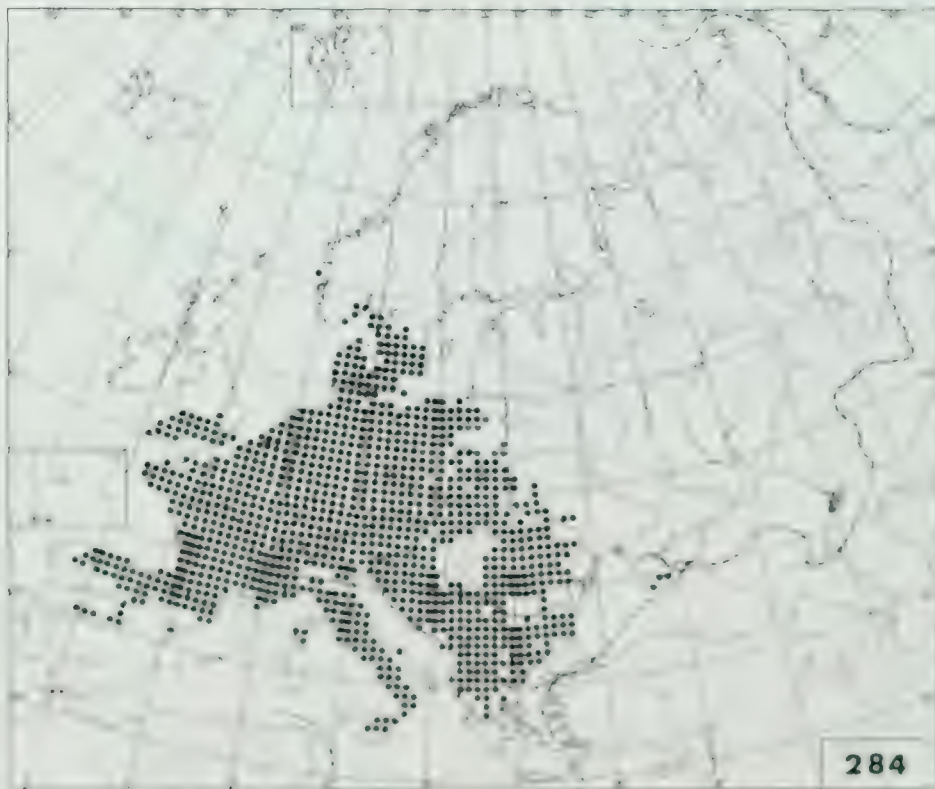
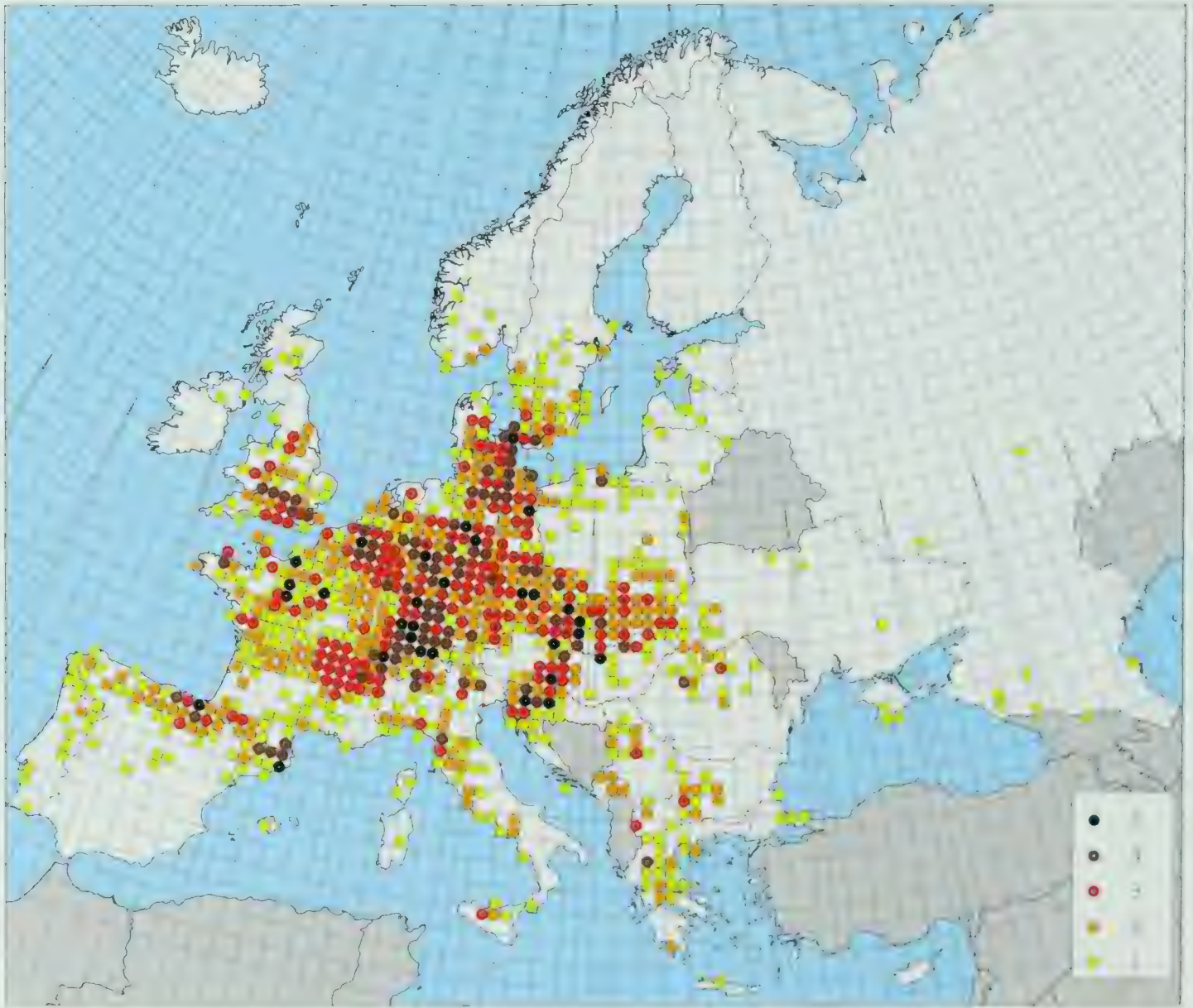
(Above) Figure 3. Cumulative distribution map of 3 species bound with *Pinus sylvestris* (*Bankera fuligineo-alba*, *Boletopsis grisea* and *Suillus flavidus*). The colour of the dots gives the number of species.

(Left) Figure 4. Distribution of *Pinus sylvestris* in Europe. From *Atlas Florae Europaeae* 2 (Jalas & Suominen 1973). Courtesy of the Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo



(Above) Figure 5. Cumulative distribution map of 5 species bound with *Picea abies* (*Amylocystis lapponica*, *Hydnellum suaveolens*, *Hygrophorus purpurascens*, *Sarcosoma globosum* and *Skeletocutis odora*). The colour of the dots gives the number of species.

(Left) Figure 6. Distribution of *Picea abies* coll. in Europe. From *Atlas Florae Europaeae* 2 (Jalas & Suominen 1973). Courtesy of the Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo.



(Above) Figure 7. Cumulative distribution map of *Faerberia carbonaria*, *Hericium erinaceus*, *Leucopaxillus tricolor*, *Phylloporus pelletieri* and *Strobilomyces strobilaceus*. The colour of the dots gives the number of species

(Left) Figure 8. Distribution of *Fagus sylvatica* in Europe. From *Atlas Florae Europaeae* 3 (Jalas & Suominen 1976). Courtesy of the Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo.

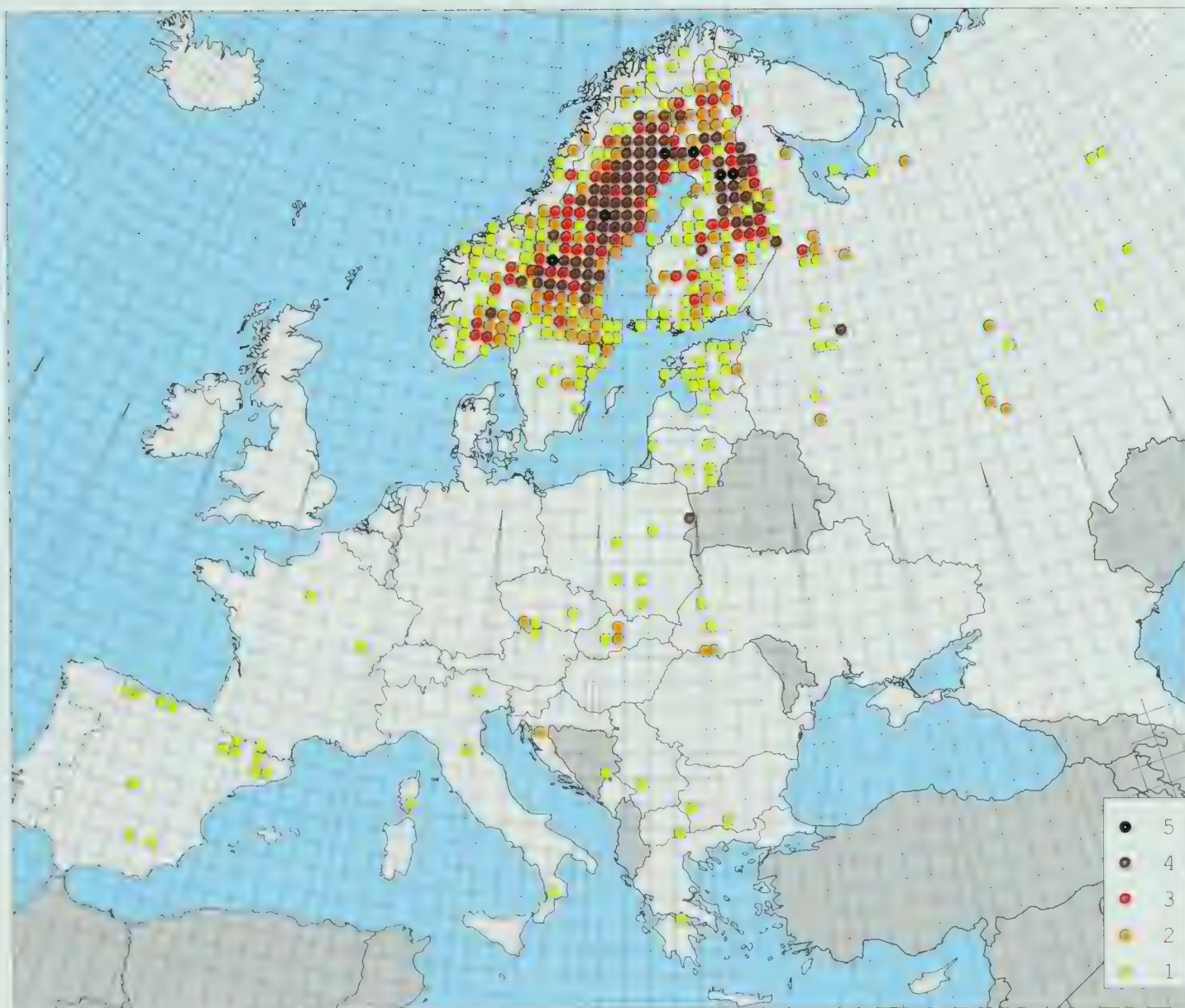


Figure 9. Cumulative distribution map of 5 “boreal” species (*Amylocystis lapponica*, *Antrodia albobrunnea*, *Haploporus odorus*, *Pycnoporellus alboluteus* and *Skeletocutis odora*). The colour of the dots gives the number of species.

An additional argument in favour of this hypothesis is the fact that four of the five species have been recorded at the same place on the eastern border of Poland, at a much lower latitude than the Boreal domain. That place is the Białowieża national park, which is an old growth forest in which “kelo” trees are even present (Niemelä et al. 2002).

Subboreal species. The distribution of *Tulostoma niveum* (p. 129) is almost entirely confined to the Subboreal zone (Boreo-Atlantic sector of the Atlantic domain and Boreo-nemoral sector of the Central-European domain). It grows mostly among mosses on calcareous rocks, occasionally in xerophytic grasslands and heaths.

Southern species. The following four species are growing in more or less thermophilic forests in southern Europe (see fig. 10).

The three first ones, *Amanita caesarea* (p. 38), *Boletus dupainii* (p. 95) and *Cortinarius tomochlorus* (p. 70) are mostly connected with oak species (*Quercus* spp.). Their distribution fits well with the distribution of *Quercus pubescens* (fig. 11), with the addition of the Iberian Peninsula.

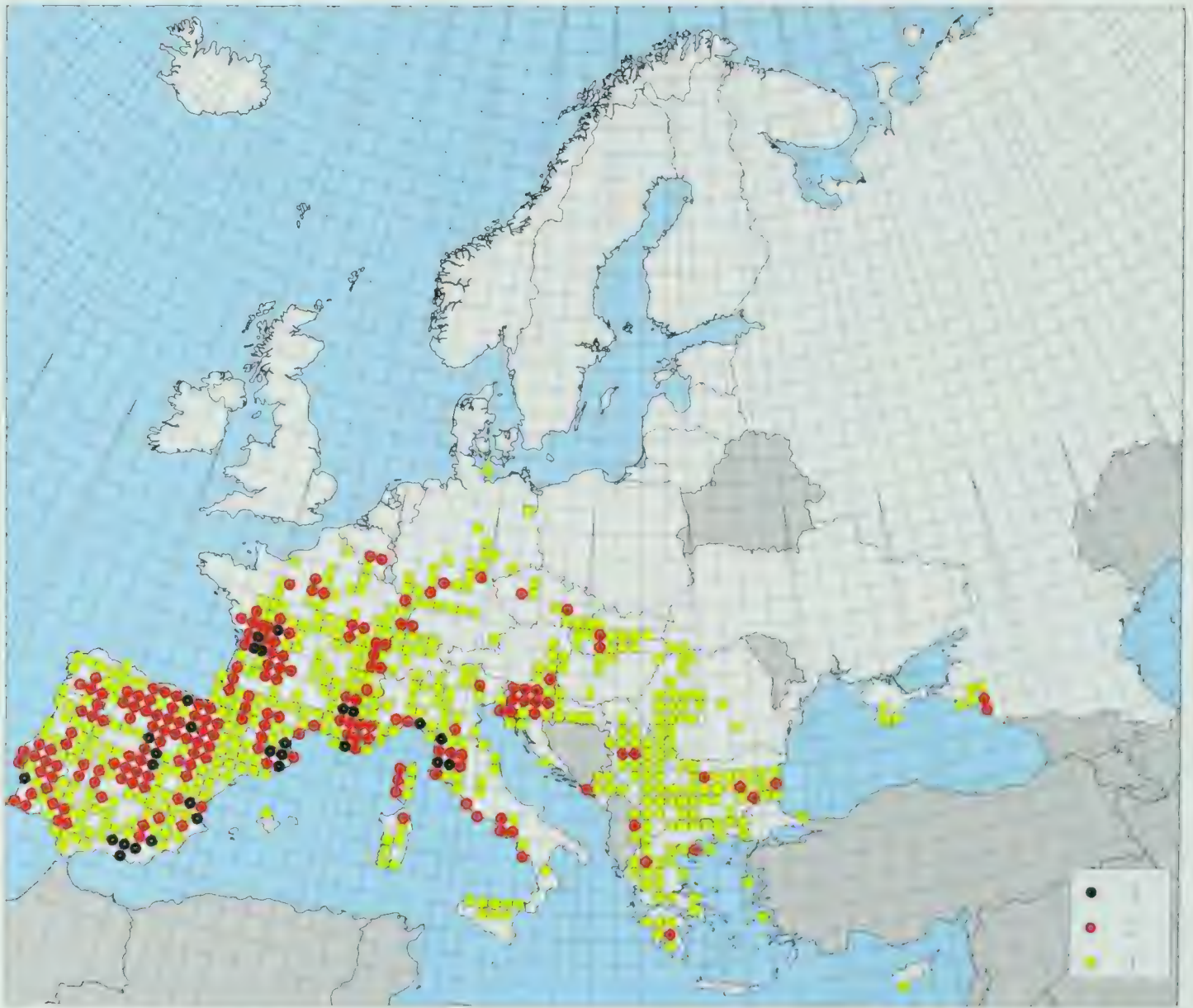


Figure 10. Cumulative distribution map of 4 southern species (*Amanita caesarea*, *Boletus dupainii*, *Cortinarius ionochlorus* and *Torrendia pulchella*). The colour of the dots gives the number of species.



Figure 11. Distribution of *Quercus pubescens* s.l. in Europe. From *Atlas Florae Europaeae* 3 (Jalas & Suominen 1976). Courtesy of the Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo.

The fourth species, *Torrendia pulchella* (p. 124), lives in connection with *Quercus* spp., *Pinus pinaster*, *P. pinea* and *Cistus* spp. It is mostly present in the Iberian Peninsula. Its area corresponds with the western half of the cumulated distribution of *Pinus pinaster* and *P. pinea* (Jalas & Suominen 1973: resp. map 163 and 174).

The northernmost growth place of *Amanita caesarea* (Bielinek, in western Poland) is a very xerothermic site which has a great interest at a myco- and phytogeographical point of

view (Kiedrzyński & Jakubowska-Gabara 2014). It is also the northernmost site in Europe for *Montagnea radiosa* (p. 121) and *Quercus pubescens* (p. 24). See more details on p. 39. It is a surprise to discover that a site exhibiting such an extreme meridional character is situated in the same country and exactly at the same latitude as the Białowieża national park, which is a southern refuge for “boreal” species (see above).

Mountain species. Five of the species treated in this work are mostly living in mountain biotopes (especially Pyrenees, the Alps and other mountains in Central Europe). These species are *Hymenochaete cruenta* (p. 180), *Laricifomes officinalis* (p. 170) and *Suillus sibiricus* (p. 108), already cited above, as well as *Hygrophorus marzuolus* (p. 85) and *Lyophyllum favrei* (p. 63). A cumulative map is given at figure 12. It is interesting to note that the distribution area of the two last taxa is much smaller than the area covered by their main hosts (*Picea abies*, *Pinus sylvestris*, *Fagus*).

Coastal species. Three of the treated species are most particularly growing in dunes along the seashores (mainly North Sea and Baltic Sea). Exceptionally, they can also be observed

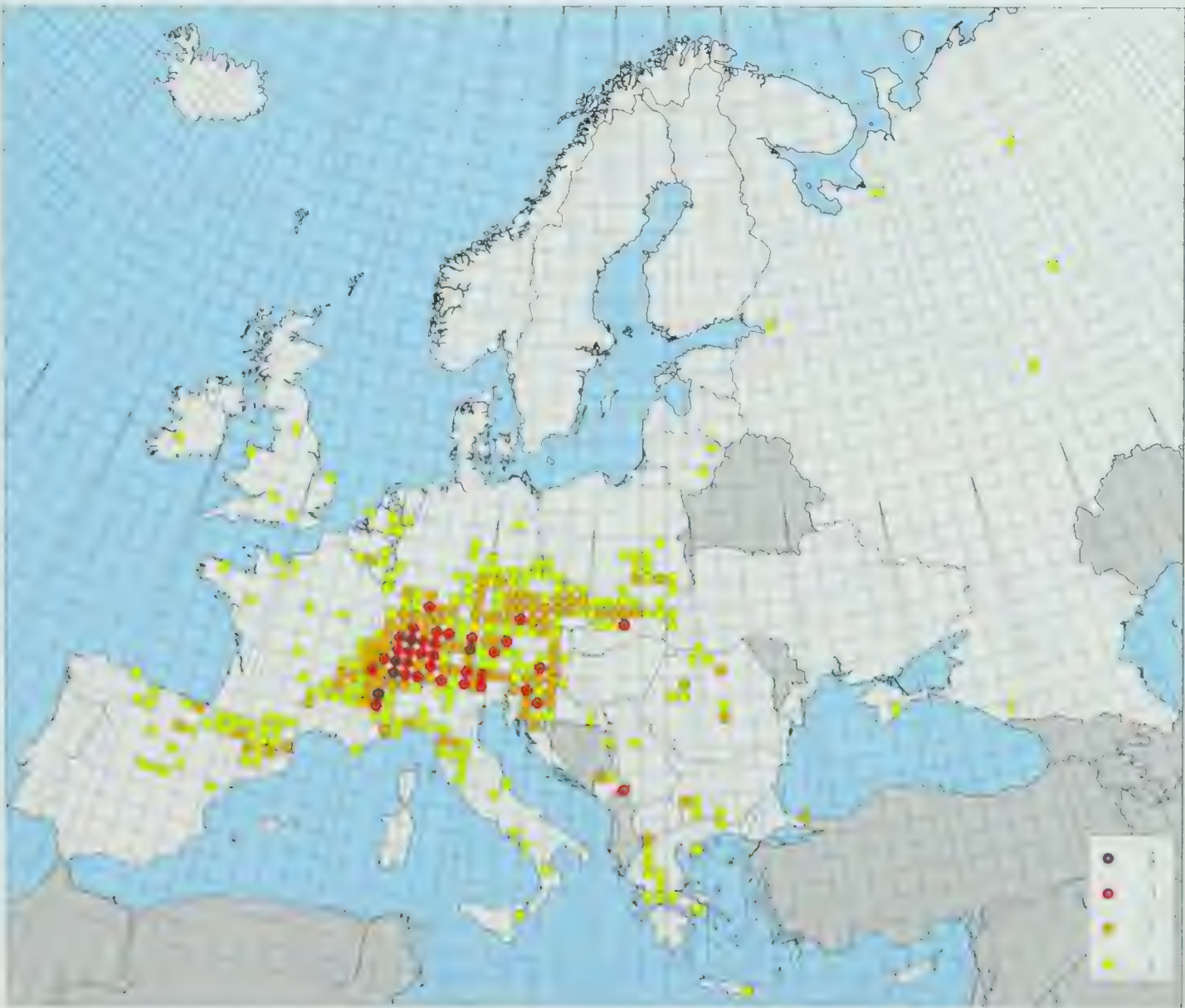


Figure 12. Cumulative distribution map of 5 mountain species (*Hygrophorus marzuolus*, *Hymenochaete cruenta*, *Laricifomes officinalis*, *Lyophyllum favrei* and *Suillus sibiricus*). The colour of the dots gives the number of species.

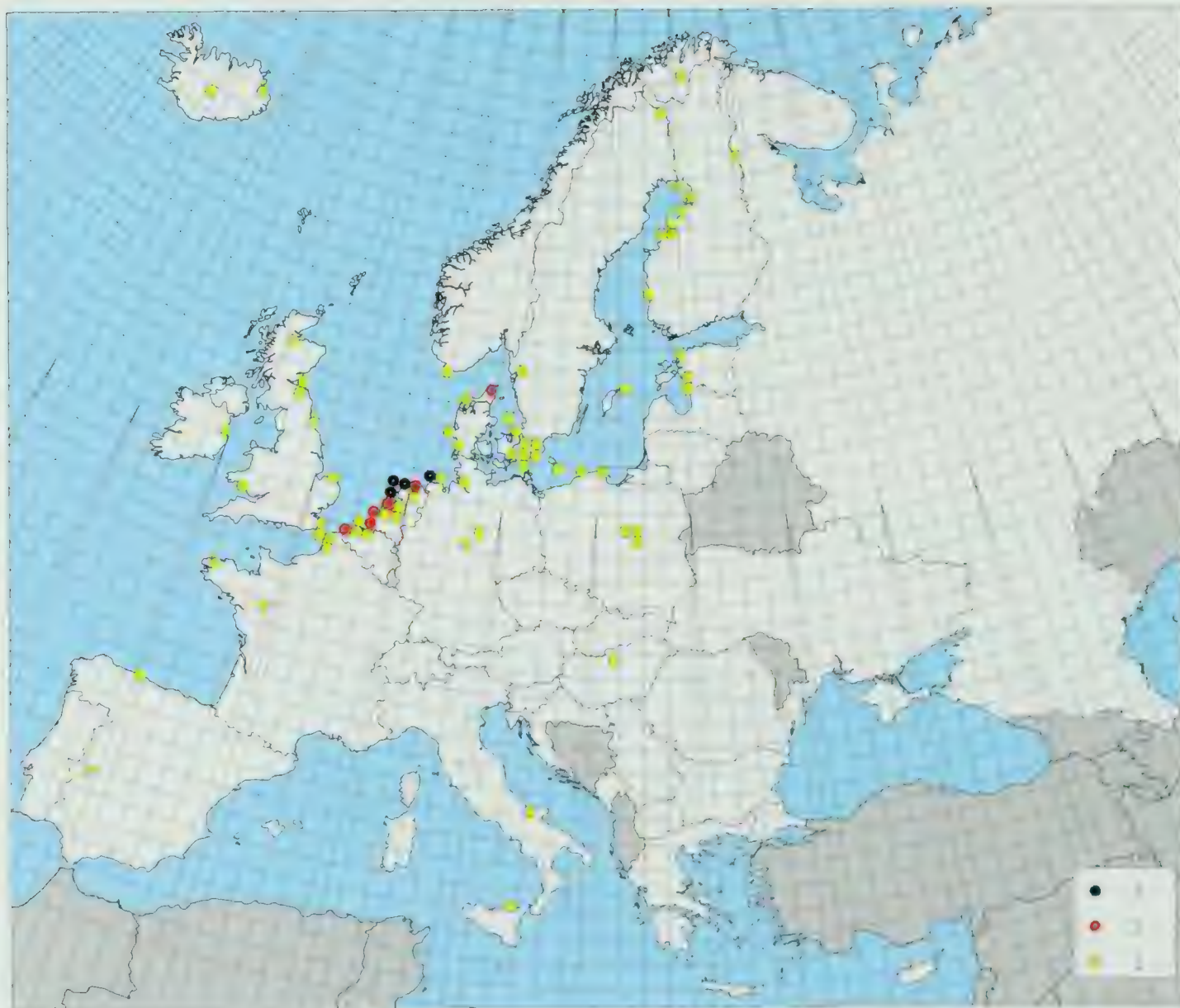


Figure 13. Cumulative distribution map of 3 coastal species (*Hohenbuehelia culmicola*, *Laccaria maritima* and *Poronia erici*). The colour of the dots gives the number of species.

in inland dunes or in steppe-like vegetation. A cumulative map is given at figure 13. These species are:

- *Hohenbuehelia culmicola* (p. 49) which mainly develops as a saprotroph on *Ammophila arenaria*.
- *Laccaria maritima* (p. 52) which is ectomycorrhizal on *Salix daphneoides*, *S. repens* and *Pinus sylvestris*.
- *Poronia erici* (p. 218) which is a coprophilic species, mainly growing on rabbit droppings.

Towards a European Red List

Mapping a species can also help to understand its ecology and to follow the evolution of its populations. It also gives a picture of the status of the species at the European level. However, we did not attempt to estimate any degree of threat at the European level for the 51 species treated here. This point remains to be defined, after an evaluation of the status

of each species in the different countries, according to the IUCN criteria. For the application of those criteria to fungi, see Dahlberg & Mueller (2011); for a discussion about the harmonization of Red Lists for threatened species in Europe, see De long et al. (2003); see also Minter (2010).

An ECCF group is working on the project of a European Red-List of Fungi. A first document on threatened mushrooms [T-PVS (99) 39] was presented at the 19th Meeting of the Bern Convention, but not accepted. A second document [T-PVS (2001) 34] was informally introduced at the 21th Meeting of the Bern Convention (Dahlberg & Croneborg 2003; for the story of the project, see Senn-Irlet 2002). This report has been subsequently re-published in another presentation (Dahlberg & Croneborg 2006). A document on “Guidance for the conservation of Mushrooms in Europe” has been published by Senn-Irlett et al. (2007).

Authorship

The national coordinators were in charge to gather co-workers (see the list hereunder), to collect with their help the information concerning the distribution, ecology and status of the 51 species in their country and to make a synthesis of these data for each species. In the lists below, the names of the contributors are given in alphabetical order.

The text accompanying the maps is a synthesis, made by Peter Otto, of the data sets sent by the national coordinators, concerning ecology and status of the species. It has been completed (screening of the bibliography) and revised by André Fraiture.

The maps are based on the distribution data sent by the national coordinators and homogenized by André Fraiture. The maps themselves have been drawn by Yvan Barbier, who also realised the cumulated maps presented in the introduction.

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Distribution maps and comments

This part of the work presents the distribution maps of the 51 species in Europe, together with comments. The taxa are sorted in systematic order. Data are presented as follows.

Nomenclature

The correct name of the species is given, with the authorship and the position in the systematics (phylum, order and family, after Kirk et al. 2008). The main synonyms, misapplied and excluded names are mentioned, sometimes with notes.

Brief description

It gives a short description of the sporophores as well as a brief overview of the distribution, the ecology, the hosts substrate of the species and the possible threats to it.

Geography

The *global distribution* of the species is indicated, according to literature data. The bibliographical references of the consulted publications are given, together with eventual notes.

Some information and comments are provided about the *distribution in Europe*. They include a.o. indications concerning the altitudinal limits within which the species has been observed in Europe (after the data sent by the national coordinators), various comments concerning the distribution of the species on the continent and eventual comparison with the distribution of host plant(s). Some localities mentioned in the literature but not indicated on our map may be cited here.

An *areal diagnosis for Europe* is presented, after an analysis of the distribution, using the phytogeographic domains proposed by Ozenda (1994). An overview of the phytogeographic conceptions of Ozenda is proposed in the introduction.

Trophism, hosts and substrates

An indication of the trophic way of life of the species (ectomycorrhizal, saprotrophic or parasitic) is given, together with the mention of the associated organism(s) (symbiont, substrate or host) and substrate type.

Habitat

An overview of the various *vegetation* types in which the species is living is proposed.

A compilation of the *syntaxa of vegetation* transmitted by the national coordinators is also given. Since some countries did not send any data in this field, this list can't be regarded as complete. Moreover, due to the lack of a European unified nomenclature of the syntaxa, it was difficult to sort syntaxa in a logical order. It has therefore been chosen to cite, as far as possible, the syntaxa by countries, from north to south.

A list of the *Natura-2000 habitats* in which the species has been observed (sorted by numerical order of the codes) is also provided. Here again, this list is incomplete because some countries did not send any data in this field. It should also be stressed that it is not always possible to find a Natura-2000 code for a given habitat, because these codes have been attributed only to more or less natural habitats. A comprehensive list of the Natura-2000 codes can be found in the Interpretation manual of European Union habitats (Anonym 2013).

A survey of the *soil requirements* of the species (moisture, pH-value, soil types, nitrogen content, grain size, litter layer) is given, together with an evaluation of its degree of *synanthropy*.

A tentative characterization of the potential value of the species as an indicator of certain environmental conditions (*indicator value*) is provided.

Occurrence of fruitbodies (phenology)

The phenology of the species, especially the period during which it produces sporophores in the different regions of Europe, is indicated.

Frequency

An estimation of the *number of current known sites* in Europe is given, sometimes with the mention of the countries in which the species is mostly present.

A short analysis of the *changes in frequency* of the species is made, after the information sent by the national coordinators. It should be kept in mind that the increase in frequency which is mentioned in some countries (e.g. UK) for a given species, could be due to an increase in the intensity of field research rather than to an expansion of the fungus.

Threats and conservation

A summary of the main *threats* to the species is provided. The degree of threat is estimated and the main responsible factors are cited. We did not give any threat degree at the European level. This point remains to be defined, after an evaluation of the status of each species in the different countries, according to the IUCN criteria. For the application of those criteria to fungi, see Dahlberg & Mueller (2011); for a discussion about the harmonization of Red Lists for threatened species in Europe, see De Jong et al. (2003); see also Minter (2010).

The *status of conservation* is described. The countries in which the species is red-listed are cited as well as the countries in which it is protected by law.

The maps

Full circles represent squares in which the species has been recorded in 1970 or later. Empty circles represent squares in which all data are older than 1970. Theoretically, a dot on the map corresponds to a square of 50 × 50 km, covering a surface of 2500 km². However, in the triangular zones, the area covered by a dot can be considerably lower because the width (east-west) of these surfaces becomes smaller when latitude increases.

The maps have been drawn by Yvan Barbier, with the software Data Fauna-Flora (Barbier et al. 2000) and Carto Fauna-Flora (Barbier & Rasmont 2000).

Amanita caesarea (Scop.: Fr.) Pers.

Basidiomycota, Agaricales, Amanitaceae

Note: A f. *alba* (Gillet) Gilbert and a f. *lutea* (Gillet) Neville & Poumarat have been described.

Brief description

With its bright orange cap and its yellow stem, provided with a ring and a volva, this amanita is a striking fungus. It is present in the southern half of Europe, principally in the Mediterranean region, where it lives in symbiosis, mostly with oak (*Quercus*) species. It is one of the most famous edible mushrooms in Europe and it can be threatened in some regions, a.o. by excessive picking.

Geography

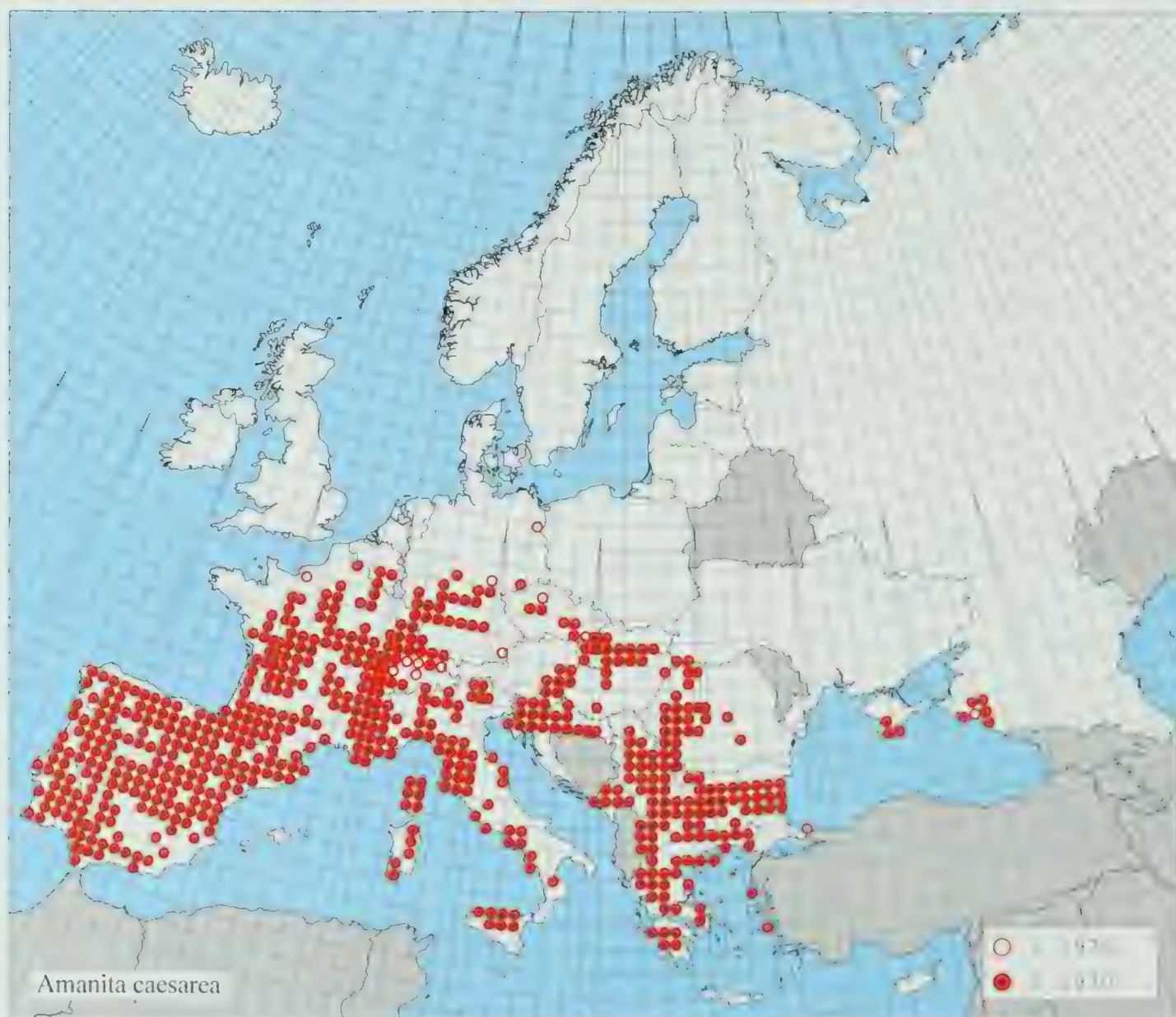
Global distribution: Europe, Asia (Georgia, Turkey, Siberia, Nepal, North Korea, Japan), Africa (Algeria, Morocco, Tunisia), North America (Mexico?), South America (Guatemala?). After Bessette et al. (1997), Guzmán & Ramírez-Guillén (2001) and Tulloss (2012), the species is probably absent from Canada and the USA (also from Mexico and Guatemala?), where confusions occurred with *A. basii* and other related species. The species has been mentioned from China (see a.o. Teng 1996) but it is probably a confusion with *A. hemibapha* (Yang 1997). The mentions from India are misidentifications as well (Bhatt et al. 2003).

Bibliography: Malençon & Bertault (1970), Adhicari & Parajuli (1994), Neville & Poumarat (2004), Wojewoda



Amanita caesarea

Photo Laurent Deparis



Distribution of *Quercus pubescens* s.l. in Europe. From *Atlas Florae Europaeae* 3 (Jalas & Suominen 1976). Courtesy of the Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo

et al. (2004), Sesli & Denchev (2008), Maire et al. (2009), Romero-Arenas et al. (2009), Flores Arzú et al. (2012), Gvritishvili et al. (2012)

Distribution in Europe The species mainly occurs from the lowlands to the lower mountain regions, only seldom above 1200 m (Italy). According to Lange (1974), the highest record was at 1550 m. See also Lange (1974, map), Fraiture & Walley (2005), Bresinsky & Dörfelt (2008).

Kraft (1956) discusses in detail the distribution of the species in Europe. The map he pro-

posed, more than 55 years ago, is amazingly correct and accurate. Compared with the map presented here, the only missing points are those of Sardinia, southern Ukraine (Crimea) and southern Russia, as well as the Polish locality discussed hereunder. Kraft says *A. caesarea* is a submediterranean species and compares its distribution with that of *Castanea sativa*, *Quercus pubescens* and *Buxus sempervirens*. The parallel with *Quercus pubescens* is probably the best one, in spite of this last species is absent from most of the Iberian Peninsula; see the map on the opposite page. The parallel with the distribution of *Vitis vinifera* (Lange 1974: 44, Arnold et al. 1998) is also interesting.

The highest latitude mentioned for the species in Europe (close to 53° lat. N) is by far the old Polish observation from Bielinek (Germ. Bellinchen), at the German border. No herbarium specimen could be traced for that observation and, looking at the distribution map, the locality could appear as a probable mistake. However (Kałucka, in litt.), this site is very particular, with calcareous soil and an extremely xerothermic character. It has a great interest at a myco- and phytogeographical point of view (Kiedrzyński & Jakubowska-Gabara 2014). Other “southern”, steppe species have been found there: *Montagnea radiosa* (also the northernmost site in Europe, see the map on p. 121) and *Gastrosporium simplex* (Senn-Irlett 2012). *Quercus pubescens* is also present on this site and, here again, it is by far the northernmost locality of that species, after the map published in *Atlas Florae Europaeae* (see map p. 38).

The distribution map proposed by Lange (1974) for *Amanita caesarea* does not include the Bielinek observation but another northern location is indicated, in the Land Kehdingen (northern Germany), at about 43°40' lat. N. This last point was probably an error; it does not appear on the maps published by Krieglsteiner (1991) and Bresinsky & Dörfelt (2008) and has not been confirmed by the German national coordinator of the ECCF Mapping project (P. Otto).

Areal diagnosis for Europe: Southern half of Europe: mainly in Medit., Therm. and Alp. (mean mountain, with *Fagus* and *Abies*); also in Atl. (south) and C-Eur. (south); absent from Arct., Bor., Sarm. and Step.

Trophism, hosts and substrates

This ectomycorrhizal species most often grows in symbiosis with *Quercus* species (*Q. cer-ris*, *frainetto*, *gussonei*, *ilex*, *petraea*, *pubescens*, *robur*, *suber*). It can also form ectomycorrhizae with *Castanea sativa* (Austria, Portugal, Spain) and *Fagus sylvatica* (Germany, Macedonia, Serbia, Slovakia, Slovenia). Outside the Fagaceae family, it is reported to be also a symbiont of *Corylus* sp. (Spain), *Tilia* spp. (Serbia), *Abies borisii-regis* (Greece), *A. cephalonica* (Greece, Pantidou 1980) and *Pinus sylvestris* (Germany). See also Neville & Poumarat (2004).

Habitat

Vegetation: The fungus mainly occurs in deciduous to sclerophyllous forests with *Quercus* spp. (associated trees belong e.g. to *Carpinus*, *Fraxinus*, *Ostrya*), less often in forests with *Fagus* and *Castanea* (see also chapter “symbiont”) and in forests where *Quercus* is mixed with conifers (*Picea* in Romania, *Pinus* e.g. in Italy, Slovenia and Ukraine). Also wood pastures with oaks in Portugal (montado) and Spain (dehesa), macchia (with *Arbutus*, *Cistus* and *Erica*) and heaths (with *Calluna*), both in Italy, as well as extensively managed grass-

lands with solitary trees (Slovenia) are suitable habitats. Outside the Mediterranean region the species is largely limited to thermophilous vegetation (mostly forests with *Quercus*, in Poland steppe-like vegetation with *Stipa*). See also Bresinsky & Dörfelt (2008).

Syntaxa of vegetation: FORESTS: *Hordelymo-Fagetum*, *Carici-Fagetum* (both Germany), *Quercetum pubescenti-petraeae* (France and Poland), *Carpinion betuli* (Czech Republic, Slovakia, Switzerland), *Potentillo albae-Quercetum petraeae* (Czech Republic), *Fraxino-Quercetea*, *Pino halepensis-Quercetea ilicis* (both France), *Quercion robori-petraeae* (Switzerland), *Quercion pubescenti-petraeae*, *Asperulo taurinae-Carpinetum*, *Luzulo-Fagetum*, *Luzulo-Quercetum* (all Hungary), *Carpino orientalis-Quercetum petraeae*, *Cytiso nigricantis-Quercetum petraeae*, *Quercetum petraeae-cerris* (all Romania), *Querco-Ostryetum carpinifoliae*, *Seslerio-Ostryetum carpinifoliae*, *Querco-Castanetum submediterraneum*, *Fraxino orni-Quercetum ilicis*, *Quercetum petraeae-cerris* (all Montenegro), *Festuco heterophyllae-Fagetum*, *Querco-Carpinetum* (both Macedonia), *Quercetum frainetto-cerris* (Bulgaria, Macedonia), *Quercion ilicis*, *Viburno-Quercetum ilicis ornetosum*, *Erico-Quercetum cerridis*, *Physospermo-Quercetum petraeae*, *Physospermo-Quercetum petraeae* (all Italy); HEATHS: *Tuberario lignosae-Callunetum* (Italy).

Natura 2000 habitats: European dry heaths (code 4030, Italy), Dehesas with evergreen *Quercus* spp. (code 6310, Portugal), *Luzulo-Fagetum* beech forests (code 9110, Hungary, Slovakia), *Asperulo-Fagetum* beech forests (9130, Hungary), Medio-European limestone beech forests of the *Cephalanthero-Fagion* (code 9150, Germany, Slovakia), Sub-Atlantic and medio-European oak or oak-hornbeam forests of the *Carpinion betuli* (code 9160, Germany), *Galio-Carpinetum* oak-hornbeam forests (code 9170, Slovakia), Riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *Ulmus minor*, *Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmion minoris*) (code 91F0, Serbia, Slovakia), Pannonic woods with *Quercus petraea* and *Carpinus betulus* (code 91G0, Austria, Croatia, Germany, Hungary, Macedonia, Slovakia), Pannonian woods with *Quercus pubescens* (code 91H0, Bulgaria, Czech Republic, Hungary, Italy, Slovakia), Euro-Siberian steppic woods with *Quercus* spp. (91I0, Hungary, Poland, Slovakia), Illyrian oak-hornbeam forests (*Erythronio-Carpinion*) (91L0, Hungary, Serbia), Pannonian-Balkan turkey oak - sessile oak forests (code 91M0, Bulgaria, Croatia, Hungary, Slovakia), Moesian beech forests (code 91W0, Bulgaria, Greece, Macedonia), Eastern white oak woods (code 91AA, Macedonia), Galicio-Portuguese oak woods with *Quercus robur* and *Quercus pyrenaica* (code 9230, Portugal), *Quercus faginea* and *Quercus canariensis* Iberian woods (code 9240, Portugal), *Castanea sativa* woods (code 9260, Bulgaria, Italy, Portugal), Hellenic beech forests with *Abies borisii-regis* (code 9270, Greece), *Quercus frainetto* woods (code 9280, Macedonia), *Quercus suber* forests (code 9330, Portugal), *Quercus ilex* and *Quercus rotundifolia* forests (code 9340, Greece, Italy, Portugal).

Soil requirements: In the Mediterranean region the species prefers dry to moderately damp soils (only in Spain also on wet soils) with a low pH-value (less often basic soils); soil types: e.g. sands of the Miocene, red-greyish soils of non-calcareous materials, sandstone, phyllite, sandy brown soil, ranker. In the northern Sub-Mediterranean and the southern temperate region (northern part of its area) the fungus is limited to warm and comparatively dry places with basic and often skeletal soils (e.g. limestone, rendzina, calcareous clay, e.g. Czech Republic, Germany, Slovenia, Russia) or acid soils (e.g. diorite, brown soil, podzol, e.g. Bulgaria, Hungary and Romania). In general the nitrogen content must be low to moderate and the fructification does not occur at places where the litter layer is thick. Lange (1974) concludes that, "if the soil conditions play an important role for the distribution, it is not the soil reaction but rather the temperature qualities and the content of accessible water."

Synanthropy: The species occurs in natural and near-natural forests as well as in plantations strongly influenced by man (Spain).

Indicator value: Generally, the species seems to be a good indicator for nitrogen-poor soils and, especially in temperate regions, for warm habitats.



Amanita caesarea

Photo Miquel À. Pérez-De-Gregorio

Occurrence of fruitbodies (phenology)

Basidiocarps are mainly produced from early summer till autumn (July-October); in the Mediterranean region (e.g. Spain) fruitbodies can appear from May already till October.

Frequency

Number of currently known sites: More than 500.

Changes in frequency: In Austria, Czech Republic, Macedonia, Montenegro, Portugal, Slovakia and Slovenia, a moderate to strong decrease has been noticed for the last decades. In other countries (e.g. France and Greece), no change of frequency is mentioned. In Romania an increase of sites is reported. In Belgium, the species remains very rare but seems to be slowly increasing too (Fraiture & Walley 2005).

Threats and conservation

Threats: Sites are mainly threatened by silvicultural intensification (e.g. fertilization, clear felling, pesticides), irresponsible picking and nitrogen deposition due to air pollution.

Status of conservation: The species is red listed in Austria, Bulgaria, Czech Republic, France (regional red list), Germany, Hungary, Montenegro, Poland, Russia (regional red list), Serbia, Slovakia, Switzerland and Ukraine. It is protected by law in Croatia, Czech Republic, Germany, Serbia, Slovakia, Slovenia and Ukraine.

Amanita friabilis (P. Karst.) Bas

Basidiomycota, Agaricales, Amanitaceae

Synonyms: *Amanita alnicola* Rouzeau & F. Massart, *Amanita sternbergii* Velen., *Amanitopsis friabilis* (P. Karst.) Sacc.

Brief description

A small, greyish amanita, without annulus and lacking a true volva. This very discreet mushroom goes easily unnoticed. It is mostly present in Boreal and Central-European domains and grows on wet soils, in symbiosis with alder (*Alnus*) species. It is mainly threatened by drainage and deforestation.

Geography

Global distribution: Europe, Asia (Turkey), North America (Greenland).

Bibliography: Bas (1974), Jahn (1976), Fraiture (1993), Corriol (1999), Fraiture & Walley (2005), Bresinsky & Dörfelt (2008), Sesli & Denchev (2008).



Amanita friabilis

Photo: Julian Nitzke

Distribution in Europe: The species mainly occurs from the lowlands to the mountainous regions, rarely higher and then up to 1800-1900 m, in symbiosis with *Alnus viridis* (Austria, Italy, Switzerland).

Areal diagnosis for Europe: Mainly Bor., C-Eur. and Alp.; also Sarm. (north-west) and Atl.; very rare in Therm. and Medit.; absent from Arct. and Step.

Trophism, hosts and substrates

This ectomycorrhizal fungus is always living in symbiosis with *Alnus* (*A. glutinosa*, *A. incana*, *A. viridis*).

Habitat

Vegetation: The species is limited to forests, groves and bushes with *Alnus* in wet to temporarily flooded biotopes. It is reported from the following vegetation types: alder forests (e.g. Sweden), alder forests with *Filipendula* (Estonia), alluvial forests (e.g. Germany), swamp woods (Czech Republic), forested creeks, streams and sea banks, subalpine bushes with *Alnus viridis*. See also Bas (1974), Fraiture (1993), Corriol (1999), Bresinsky & Dörfelt (2008).



Syntaxa of vegetation: FORIS: *Alno-Padion*, *Alno-Ulmion*, *Stellario nemorum-Alnetum glutinosae*, *Pruno-Fraxinetum* (all Germany), *Alnetum incanae* (Germany, Switzerland), *Alnion glutinosae* (Czech Republic), *Alno glutinosae-Ulmion minoris*, *Alnion alnobetulae* (both France).

Natura 2000 habitats: Dehesas with evergreen *Quercus* spp. (code 6310, Portugal), Fennoscandian deciduous swamp woods (code 9080, Finland), Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*) (code 91E0, Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, France, Germany, Italy, Latvia, Netherlands, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, UK).

Soil requirements: The fungus is restricted to wet soils (high groundwater level) and tolerates temporary flooding. Regarding pH-value, the species is euryoecious (range from acid to basic). According to the ecological requirements of *Alnus* the fungus occurs on nutrient rich to moderately rich soils, e.g. gley, peat soils, silicate sands, vega. The thickness of the litter layer is reported as variable.

Synanthropy: The species avoids habitats strongly influenced by man.

Indicator value: It is a characteristic fungal component of natural or near-natural *Alnus* biotopes and of wetland habitats in general.

Occurrence of fruitbodies (phenology)

Basidiocarps are mainly produced in late summer and autumn (August-October). In Russia, fruitbodies have already been found in May, in Finland from June till October. In Italy a very irregular fructification has been observed (only every 5-10 years).

Frequency

Number of currently known sites: About 100.

Changes in frequency: The species is considered as extinct in the Netherlands (not observed after 1988). In France and Sweden a decrease is reported for the last decades. E.g. in Estonia no changes have been noticed. In UK an increase in the number of sites is reported.

Threats and conservation

Threats: Sites are mainly threatened by drainage and deforestation.

Status of conservation: The species is red listed in Austria, Czech Republic, Estonia, Finland, France, Germany, Hungary, Netherlands, Norway, Russia (only regional red list), Slovakia, Sweden, Switzerland and UK. See also Dahlberg & Croneborg (2003, 2006).

Armillaria ectypa (Fr.: Fr.) Lamoure
Basidiomycota, Agaricales, Physalacriaceae

Synonyms: *Armillariella ectypa* (Fr.: Fr.) Singer, *Clitocybe ectypa* (Fr.: Fr.) Gillet var. *ectypa*.

Excluded: *Clitocybe ectypa* (Fr.: Fr.) Gillet var. *infumata* Bres. [= *Lyophyllum infumatum* (Bres.) Kühner].

Note 1: The name is sanctioned by Fries, *Syst. mycol.* 1: 108 (sub *Agaricus ectypus*).

Note 2: After Volk & Burdsall (1995), the combination in the genus *Armillaria* has been made by Emel (1921: 59) and the combination by Lamoure (1965) is superfluous. However, in his paper, Emel obviously doesn't accept the inclusion of the species in the genus *Armillaria* (he even does not accept the genus *Armillaria* itself and the title of his thesis is "Le genre *Armillaria* Fr.: sa suppression de la nomenclature botanique"). Moreover, his thesis has perhaps not been effectively published according to the rules of the Code. As a consequence, the combination by Emel is not valid (Art. 36.1.(a) and 32.1).

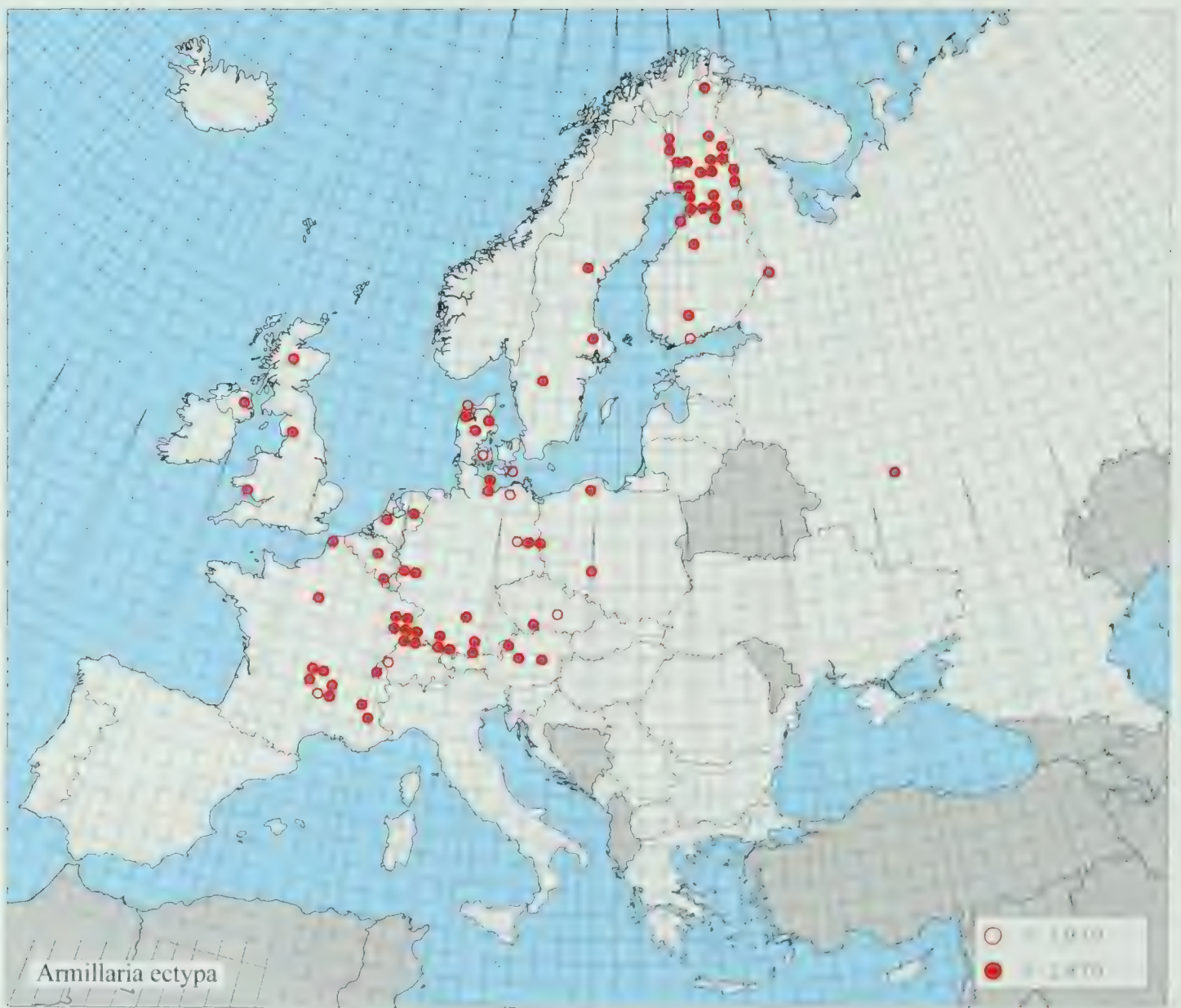
Brief description

A brownish hygrophanous agaric, with whitish to pinkish gills, mostly present in boreal and central Europe. It grows in mires, solitary or in loose clusters of a few carpophores, and decays saprotrophically a.o. dead peat mosses (*Sphagnum*) and sedges (*Carex*). The species is a good indicator for natural or only weakly disturbed bogs and mires and is threatened by drainage operations.



Armillaria ectypa

Photo Daniel Ghyselinck



Geography

Global distribution: Europe, Asia (Turkey, Siberia, Japan, China).

Bibliography: Benkert (1997), Zolciak et al. (1997), Ainsworth (2003, 2004), Fraiture & Walley (2005), Guillaumin (2005), Ohenoja (2006), Bresinsky & Dörfelt (2008), Sesli & Denchev (2008), Stasinska (2011)

Distribution in Europe: The species mainly occurs in the lowlands, only seldom in mountainous regions (Germany, in France also above 1200 m).

Besides localities indicated on the map, the species has also been mentioned from Slovakia (Ainsworth 2003: 5), but we have not received nor found any precise indication which would confirm the presence of the species in that country.

After Zolciak et al. (1997), it could be a relict of the ice age.

Areal diagnosis for Europe: Mainly Bor. and C-Eur.; also Atl. and Alp.; a single record in Arct. and another in Sarm. (both Finland); absent from Therm., Medit. and Step.

Trophism, hosts and substrates

The species is probably saprotrophic, decaying dead peat mosses (*Sphagnum* spp.), sedges (e.g. *Carex rostrata*) and presumably also reed (*Phragmites australis*, UK); possibly also with a potential to invade living plants (France).

Habitat

Vegetation: The fungus mainly inhabits transitional mires and is usually associated with *Sphagnum* spp. and *Carex* spp., but not seldom also with e.g. *Eriophorum latifolium* and *Menyanthes trifoliata*. Occasionally, it also occurs in ombrogenic mires with *Andromeda polifolia*, *Betula nana*, *Vaccinium oxycoccus* etc. (Sweden, in aapa mires), in reed dominated by sedges, at paludified pond shores (e.g. Finland), in alkaline fens (e.g. Sweden), near calcareous springs (Denmark, Germany, Ireland, UK) and in mesotrophic karst mires (Russia). There is an old record in a fresh pine forest (*Leucobryo-Pinetum molinietosum*) in Poland. See also Wilhelm (1993), Benkert (1997), Zolciak et al. (1997), Ainsworth (2003, 2004), Ohenoja (2006), Wright (2007), Bresinsky & Dörfelt (2008), Stasińska (2011).

Syntaxa of vegetation: BOG AND SWAMP VEGETATION: *Sphagnetum magellanicum*, *Cratoneurion commutati*, *Caricion davallianae*, *Primulo-Schoenetum ferruginei*, *Magnocaricion*, *Caricion elatae*, *Caricetum rostratae* (all Germany), *Scheuchzerio-Caricetea fuscae* (Czech Republic), *Rhynchosporion albae* (Belgium), *Caricetalia fuscae* (France), *Oxycocco-Sphagnetum* (France, Russia).

Natura 2000 habitats: Active raised bogs (code 7110, Austria, Belgium, France, Slovakia), Degraded raised bogs still capable of natural regeneration (code 7120, Slovakia), Blanket bogs (code 7130, France, UK), Transition mires and quaking bogs (code 7140, Czech Republic, Estonia, Finland, France, Germany, Latvia, Netherlands, Poland), Depressions on peat substrates of the *Rhynchosporion* (code 7150, Czech Republic), Fennoscandian mineral-rich springs and springfens (code 7160, Finland), Semi-natural tall herb humid meadows (code 7210, Switzerland), Petrifying springs with tufa formation (*Cratoneurion*) (code 7220, Denmark), Alkaline fens (code 7230, Denmark, Finland, Germany, Netherlands, Sweden, Switzerland, UK), Aapa mires (code 7310, Sweden).

Soil requirements: The species colonizes peat and organotrophic substrates (respectively, purely organic or with a low mineral content). PH-value: from strongly acid to more or less basic but Ainsworth (2003) doubts the species could be able to develop in really acid fens. Nitrogen content: very low (oligotrophic) to rather low (mesotrophic). The substrates below the peat layers may differ considerably, without strong influence on the occurrence of the fungus: sandstone, agglomerate, claystone, crystalline rocks (all Czech Republic), but also limestone (Germany, Russia).

Synanthropy: The species is restricted to natural and near-natural bogs and mires.

Indicator value: The species is a good indicator for undisturbed or only weakly modified bogs and mires.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from early summer till late autumn (June-November).

Frequency

Number of currently known sites: About 50.

Changes in frequency: In Denmark, Finland, France, Germany and Sweden, a decrease has been noticed for the last 50 years. In UK and Russia, an increase in sites is reported.

Threats and conservation

Threats: The number of sites decreased mainly by large-scale draining of bogs and mires.

Status of conservation: The species is red listed in Austria, Czech Republic, Denmark, Finland, France, Germany, Netherlands, Russia (regional red list), Sweden, Switzerland and UK. See also Dahlberg & Croneborg (2003, 2006).

Hohenbuehelia culmicola Bon

Basidiomycota, Agaricales, Pleurotaceae

Synonyms: *Acanthocystis petaloides* var. *macrospora* Bon, *Hohenbuehelia petaloides* var. *macrospora* (Bon) Courtec.

Excluded: *Hohenbuehelia culmicola* Singer

Note 1: *Hohenbuehelia culmicola* Singer, in *Fieldiana, Bot.*, NS **21**: 39 (1989), is described from tropical forest in Columbia and Argentina. It is a different taxon and a later homonym.

Note 2: *Acanthocystis petaloides* var. *macrospora* Bon, in *Bull. trim. Soc. mycol. France* **86** (1): 163 (1970), has been described before *Hohenbuehelia culmicola* Bon, in *Doc. mycol.* **10** (n°37/38): 89 ("1979", 1980), but there is no competition between ranks (Art. 11.2).

Note 3: *Hohenbuehelia culmicola* and *Hohenbuehelia petaloides* var. *macrospora* are considered as two different taxa by Courtecuisse (1984: 30).

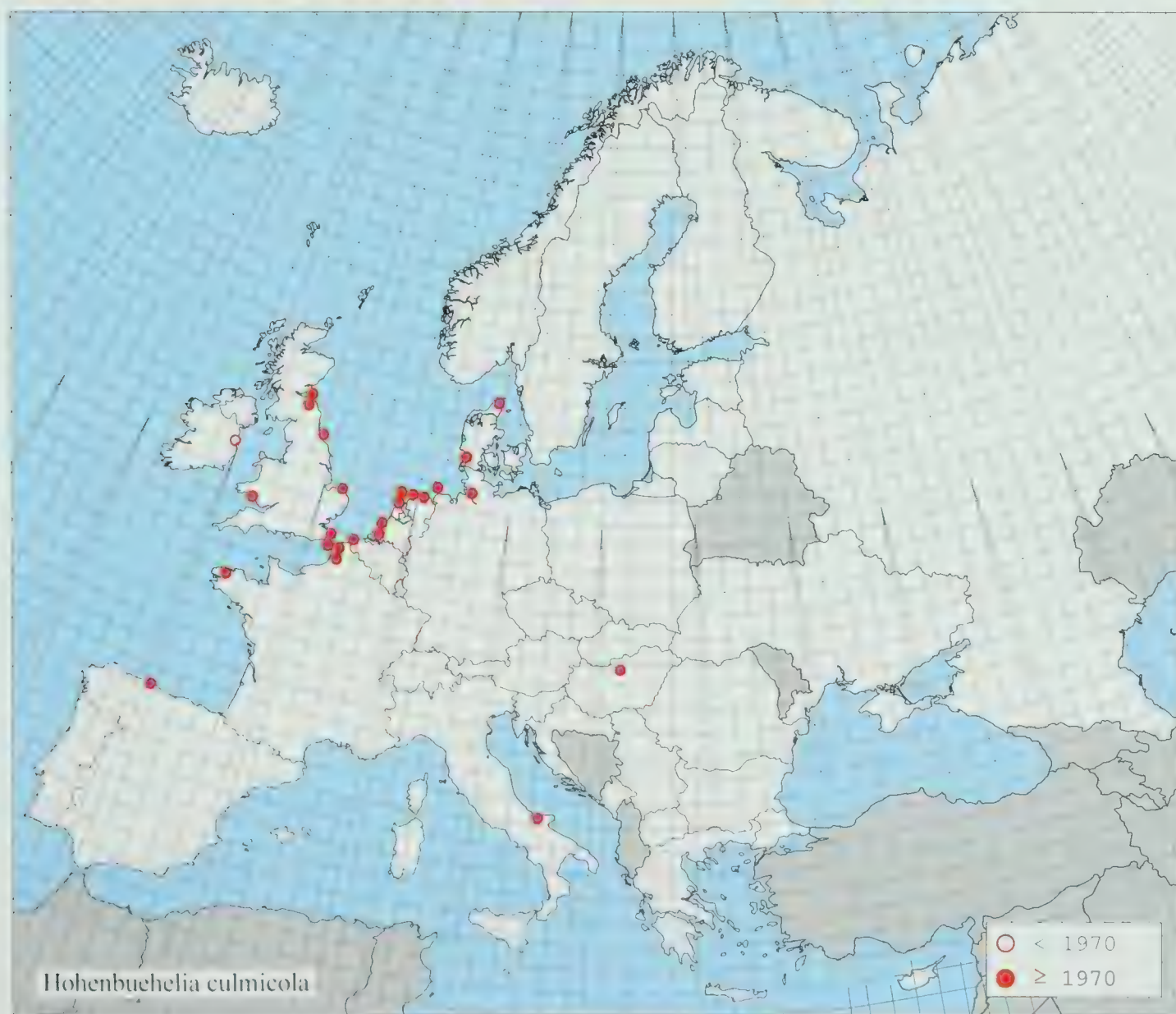
Brief description

A small agaric, with a clitocyboid or pleurotoid habit, a blackish brown cap and whitish decurrent gills. It grows almost exclusively along the coasts of the Atlantic domain, especially on white dunes, as a saprotroph on the culms of *Ammophila arenaria*. It fruits in October-December (-April). It is a good indicator for undisturbed or only weakly perturbed coastal dunes and is mainly threatened by coastal management and by disturbance of sandy coasts for recreation facilities.



Hohenbuehelia culmicola

Photo Yves Deneyer



Geography

Global distribution: not mentioned outside Europe, but possibly also present in the Asian steppe zone.

Distribution in Europe: The species is restricted to coastal dunes and steppe-like vegetation and therefore to the lowlands (Fraiture & Walley 2005).

Areal diagnosis for Europe: Almost exclusively in Atl., along the coasts; one locality in Medit. (Italian coast) and another one in Therm. (Hungary, in steppic vegetation: puszta); absent from the other domains.

Trophism, hosts and substrates

The species mainly colonizes the basal part of stems, the rhizomes and probably also the fleshy roots of *Ammophila arenaria*, and was found only rarely on other grasses: *Leymus arenarius* (UK; Legon & Henrici 2005), *Koeleria glauca* (Denmark), near *Festuca* and *Stipa* (Hungary). It is considered as a saprotroph, living from dead plant material but at the beginning of colonization, a parasitic mode of nutrition also appears to be present. In Denmark, the species has even been reported from living plants.

Habitat

Vegetation: The fungus almost exclusively inhabits coastal dunes, first of all white dunes which are the typical habitat of *Ammophila arenaria*. Less often, fixed dunes (grey dunes) are colonized by the fungus, as a later successional stage at shorelines (UK). In Hungary it was found in a steppe-like vegetation (Babos 2004).

Syntaxa of vegetation: DUNES AND GRASSLAND: *Ammophilion arenariae* (France, Germany), *Festucetum vaginatae* (Hungary).

Natura 2000 habitats: Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) (code 2120, Belgium, Denmark, France, Germany, Italy, Netherlands, Republic of Ireland, UK), Fixed coastal dunes with herbaceous vegetation (grey dunes) (code 2130, UK).

Soil requirements: The occurrence of the fungus depends on the presence of the host plant. In all cases the soils were distinctly sandy, well drained, aired and rather poor in nutrients and humus (litter layer absent or thin). The pH-value was mainly basic to neutral, seldom also acid (Netherlands).

Synanthropy: The species is restricted to natural and near-natural dunes and steppe-like vegetation.

Indicator value: The species is a good indicator for undisturbed or only weakly perturbed coastal dunes.

Occurrence of fruitbodies (phenology)

Basidiocarps are mainly produced late in the year (October-December); in euoceanic regions still in January-April.

Frequency

Number of currently known sites: About 40.

Changes in frequency: In France and Netherlands no changes were reported. In UK an increase in the number of sites is mentioned.

Threats and conservation

Threats: The fungus is mainly threatened by coastal management and by disturbance of sandy coasts for recreation facilities.

Status of conservation: The species is red listed in Denmark, France, Netherlands and UK. It is included in the IUCN *Global Fungal Red List Initiative* (see their web-site). See also Dahlberg & Croneborg (2003, 2006).

Laccaria maritima (Theodor.) Singer ex Huhtinen

Basidiomycota, Agaricales, Hydnangiaceae

Synonyms: *Laccaria trullisata* subsp. *maritima* (Theodor.) O. Andersson, *Laccaria trullisata* f. *rugulospora* M. Lange.

Excluded: *Laccaria maritima* ss. Dal Savio (1984) [= *Xerula mediterranea* fide Contu 2003].

Note 1: The combination made by Singer (*Sydowia* **15**: 133, 1962) is invalid (Art. 41.5, ref. of the basionym not cited) and has been validated by Huhtinen (1987).

Note 2: The species has been considered as a synonym of *L. trullisata* by some authors. However, the type subsp. (and f.) of the latter species is North-American and its spores are bigger, with a thinner and almost smooth cell wall (Høiland 1976, Vellinga 1982, Mueller 1992).

Brief description

A small agaric, entirely brownish red, with a hygrophanous cap. It is a rare species, growing mostly in sandy nutrient-poor dunes along the coasts of the North and the Baltic seas, where it forms ectomycorrhizae almost exclusively with some willow species (*Salix repens*, *S. daphneoides*). It is mainly threatened by rarity and loss of habitats in which it is living.

Geography

Global distribution: Europe. The species has also been mentioned from North America (Greenland, Canada, USA, Mexico) but at least some of these collections could be mis-



Laccaria maritima

Photo Jan Vesterholt



takes with *L. trullisata* subsp. *trullisata*, which is much more common there and is a kind of vicariant taxon.

Bibliography: Singer (1961), Huhtinen (1987), Redhead (1989), Mueller (1991, 1992).

Distribution in Europe: The species exclusively occurs in the lowlands, most often near the coast lines (Vellinga 1982).

Areal diagnosis for Europe: rare in Atl. and C-Eur. (both northern half); very rare in Arct., Bor. and Sarm. (west); absent from Alp., Therm., Medit. and Step.

Trophism, hosts and substrates

As the other species of the genus *Laccaria*, the fungus forms ectomycorrhizae, certainly with *Salix* (*S. daphnoides*, *repens* and perhaps other species), probably also with *Pinus sylvestris* (Finland, Sweden). A trophic association with *Anemophila arenaria* has been reported in Denmark and is rather astonishing. *Laccaria maritima* has also been found in sand without any seed plant (Hoiland 1976, Huhtinen 1987).

Habitat

Vegetation: The fungus is restricted to open sandy sites. Most records come from coastal

white, grey and brown dunes (in Italy dunes with *Juniperus macrocarpa* and *J. phoenicea*), but the species was also found in inland dunes (Estonia, Poland) and at sandy shores along seas and rivers (Finland).

Syntaxa of vegetation: SHRUBS: *Salici arenariae-Hippophaëtum rhamnoidis* (Germany); DUNES AND GRASSLANDS: *Elymo-Ammophiletum* (Germany, Poland), *Ericetum tetralicis*, *Helichryso-Jasionetum-litoralis* (Poland).

Natura 2000 habitats: Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) (code 2120, Denmark, Estonia, Finland, Germany, Netherlands, Poland, Sweden), Fixed coastal dunes with herbaceous vegetation (grey dunes) (code 2130, Poland), Dunes with *Salix repens* ssp. *argentea* (*Salicion arenariae*) (code 2170, Netherlands), Northern Atlantic wet heaths with *Erica tetralix* (code 4010, Poland).

Soil requirements: The fungus always inhabits strongly sandy soils. Soil type: initial stages of postglacial sands and podzol (Poland), in Iceland also on blackish volcanic sand. The soils are rather dry to more or less wet and acid. Nutrient content: very low to rather low. Litter layer: absent.

Synanthropy: The species is restricted to natural and near-natural habitats and may be considered as anthropophobic.

Indicator value: The fungus is a very good indicator for open sandy sites poor in nutrients.

Occurrence of fruitbodies (phenology)

Basidiocarps are mainly produced from summer till autumn (August-October), in Poland still in December.

Frequency

Number of currently known sites: About 50. Surely the species was often overlooked because of its small fruitbodies and its similarity with other *Laccaria* species.

Changes in frequency: In Estonia, Finland, France and Netherlands, no changes of frequency were announced.

Threats and conservation

Threats: The fungus is vulnerable because of its specific requirement of sandy nutrient-poor sites with initial vegetation. This type of vegetation is rare in Europe and threatened e.g. by nitrogen deposition from air pollution.

Status of conservation: The species is red listed in Netherlands and Sweden.

Leucopaxillus tricolor (Peck) Kühner
Basidiomycota, Agaricales, Tricholomataceae

Synonym: *Leucopaxillus pseudoacerbus* (Costantin & L.M. Dufour) Boursier

Misapplied: *Leucopaxillus compactus* ss. auct.

Note: Fide G. Redeuilh, J. Melot and others (discussions on the Internet forum “Mycologia europaea”), the basionym of *L. compactus* (*Agaricus compactus* Fr. 1861, non Schum. 1803; Fr., nec Sow. 1809) corresponds with *Entoloma lividum*. Moreover, it should be illegitimate (later homonym).

Brief description

A very large agaricoid mushroom, with a yellowish to ochraceous brown cap, a deflexed margin, and a very robust whitish or yellowish stem. It is rather largely distributed in Europe, mainly in Central-European and Alpine domains. It lives as a terricolous saprotroph, on humus and litter, in various kind of forests, mostly deciduous, on basic to neutral soils. It is mainly threatened by deforestation.

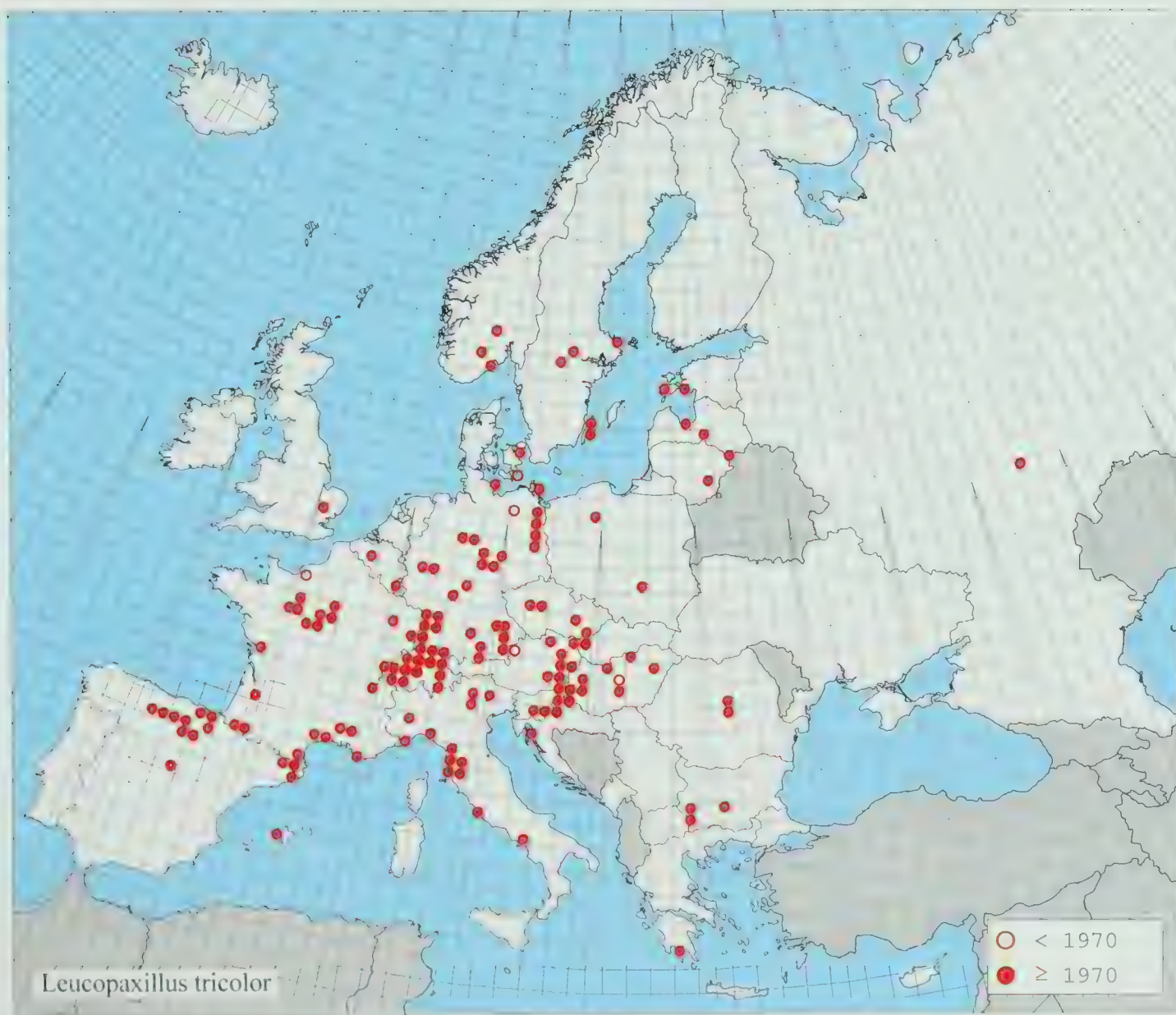
Geography

Global distribution: Europe, Asia (Turkey), Africa (Canary Islands), North America (USA).
Bibliography: Fraiture & Walley (2005), Bresinsky & Dörfelt (2008), Sesli & Denchev (2008), Kibby et al. (2009).



Leucopaxillus tricolor

Photo Daniel Ghyssels



Distribution in Europe: The species mainly occurs in the lowlands, occasionally also in lower mountain regions (e.g. Austria, Bulgaria, Romania, Slovenia); it has never been found above 1200 m.

Besides localities indicated on the map, the species is also present in Belarus (Maslovsky 2004).

Areal diagnosis for Europe: Mainly C-Eur. and Alp.; also Sarm., Atl., Therm. and Medit.; very rare in Bor. (south); absent from Arct. and Step.

Trophism, hosts and substrates

The fungus is a terricolous saprotroph and decays leaf litter and humus particles from woody plants, possibly also from herbaceous ones.

Habitat

Vegetation: The fungus mainly occurs in forests, most often in different kinds of deciduous forests, e.g. beech, oak-hornbeam, dry grassy oak, alluvial and sub-Mediterranean forests (e.g. with *Carpinus orientalis* in Croatia), but also in sclerophyllous (*Quercus ilex*, *rotundifolia*, *suber* [e.g. Italy]) and mixed forests (e.g. *Castanea*, *Fagus*, *Picea*, *Pinus* in Slovenia).

The species was found rather rarely in deciduous plantations, in dry grasslands near forest edges (e.g. Germany), in wooded dunes (e.g. Hungary), wooded grasslands (Estonia), wooded pastures (e.g. Finland) and exceptionally in coniferous forests (*Cupressus sempervirens* in Italy). Typical associated fungi in beech forests are e.g. *Boletus appendiculatus*, *B. impolitus* and *Russula foetens*. See also Bresinsky & Dörfelt (2008).

Syntaxa of vegetation: FORSIS: *Galio odorati-Fagetum*, *Hordelymo-Fagetum*, *Carici-Fagetum*, *Ulmion minoris*, *Quercu-Ulmetum minoris* (all Germany), *Galio sylvatici-Carpinetum* (Germany, Poland), *Tilio cordatae-Carpinetum betuli* (Poland), *Tilio-Quercetum* (Lithuania), *Rubio-Fagetum*, *Aceri monspessulani-Fagetum*, *Rusco-Quercetum petraeae*, *Viburno lantanae-Quercetum petraeae*, *Quercetalia pubescenti-sessiliflorae*, *Quercetalia ilicis* (all France), *Carpinion*, *Cephalanthero-Fagenion* (both France, Germany), *Quercu-Carpinetum* (Czech Republic, Romania), *Quercetum pubescentis* (Bulgaria), *Erico-Quercetum cerridis*, *Cytiso-Quercetum pubescentis* (both Italy); GRASSLANDS: *Mesobromion erecti*, *Xerobromion*, *Mesobrometum*, *Pulsatillo-Caricetum humilis* (all Germany).

Natura 2000 habitats: Wooded dunes of the Atlantic, Continental and Boreal region (code 2180, France), Fennoscandian wooded meadows (code 6530, Estonia), Fennoscandian hemiboreal natural old broad-leaved deciduous forests (*Quercus*, *Tilia*, *Acer*, *Fraxinus* or *Ulmus*) rich in epiphytes (code 9020, Estonia, Latvia, Lithuania, Sweden), Fennoscandian wooded pastures (code 9070, Finland, Sweden), *Luzulo-Fagetum* beech forests (code 9110, Slovenia), *Asperulo-Fagetum* beech forests (code 9130, Germany, Sweden, Switzerland), Medio-European subalpine beech woods with *Acer* and *Rumex arifolius* (code 9140, Switzerland), Medio-European limestone beech forests of the *Cephalanthero-Fagenion* (code 9150, Bulgaria, Denmark, France, Germany), *Galio-Carpinetum* oak-hornbeam forests (code 9170, Germany, Poland), Old acidophilous oak woods with *Quercus robur* on sandy plains (code 9190, Romania), Riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *Ulmus minor*, *Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmion minoris*) (code 91F0, Germany), Pannonic woods with *Quercus petraea* and *Carpinus betulus* (code 91G0, Austria, Croatia), Euro-Siberian steppic woods with *Quercus* spp. (code 91H0, Czech Republic), *Castanea sativa* woods (code 9260, Croatia), *Quercus ilex* and *Quercus rotundifolia* forests (code 9340, France, Italy).

Soil requirements: The species prefers mesotrophic basic to neutral soils and has been only exceptionally found on distinctly acid soils (Hungary, Romania). The majority of records were made on rather dry sites but the fungus was also recorded from wet sites (e.g. Estonia, Spain). Soil type: e.g. cambisols, luvisols and regosols (all Estonia), loess (Czech Republic), renzina, brown soil, podzol (e.g. Romania). Geologic substrate: e.g. limestone, sandstone, phyllites. Grain size: from sand to clay. Litter layer often present.

Synanthropy: The fungus mainly inhabits natural and near-natural forests, occasionally also semi-natural biotopes (plantations, grasslands).

Indicator value: At the European scale the fungus is rather euryoecious and therefore doesn't indicate specific ecological conditions.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from summer till late autumn (July-November).

Frequency

Number of currently known sites: About 150.

Changes in frequency: In Estonia, there is no record after 1984. In France, Hungary, Lithuania and Slovenia, a decrease has been noticed for the last 2-5 decades. In Austria and Slovakia no change of frequency was observed.

Threats and conservation

Threats: The fungus is mainly threatened by silvicultural activities damaging the sites (first of all by clear felling).

Status of conservation: The species is red listed in Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Hungary, Lithuania, Norway, Poland (regional red list), Spain and Sweden. The fungus is protected by law in Croatia, Latvia, Lithuania and Slovenia. See also Dahlberg & Croneborg (2003, 2006).

Tricholoma colossus (Fr.) Quél.

Basidiomycota, Agaricales, Tricholomataceae

Synonyms: *Megatracholoma colossus* (Fr.) G. Kost, *Armillaria colossus* (Fr.) Boud. ex Sacc.

Note 1: Despite Boudier (*Bull. trim. Soc. mycol. France* **16**: 18-20 + pl. I, 1900) clearly mentions that this species should be transferred in the genus *Armillaria*, he never writes the binome “*Armillaria colossus*”. Consequently, this combination has not been validly published (Art. 35.2). Saccardo (*Syll.* **16**: 20, 1902) cites “*Armillaria colossus* (Fr.) Boud.” and one may consider he validated Boudier’s combination.

Note 2: Since « colossus » is not used here as an adjective but as a noun in apposition, it retains its own gender and termination, irrespective of the gender of the generic name (Art. 23.5). Therefore, we should write *T. colossus* and not *T. colossum*.

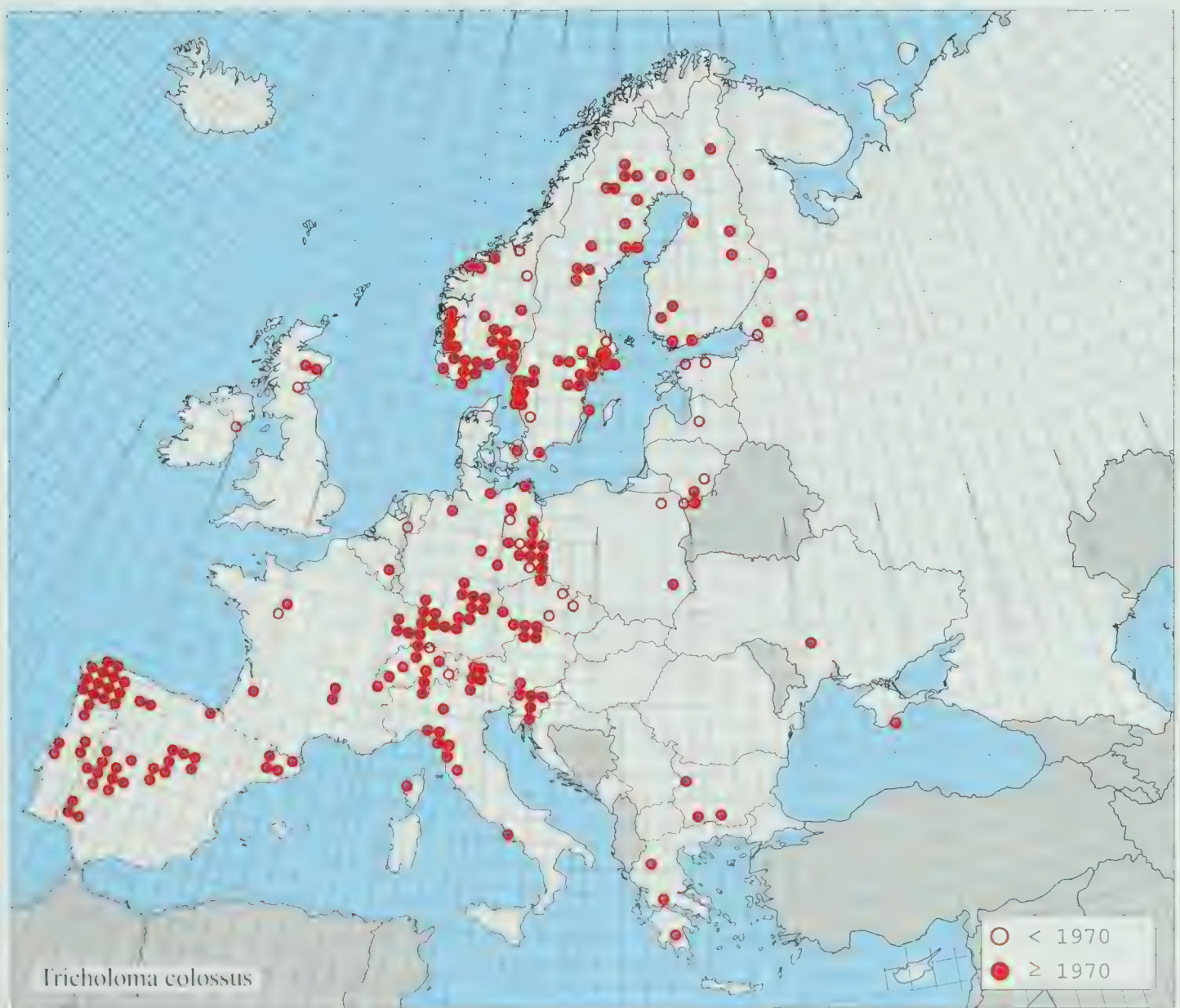
Brief description

A large to very large tricholomatoid agaric, with a very robust appearance, entirely whitish then reddish brown or pinkish. The white flesh slowly turns to the pink when cut. This rare species is rather largely distributed in Europe but mainly present in the Central-European and Mediterranean domains. It forms ectomycorrhizae with various species of pines, mostly with Scots pine (*Pinus sylvestris*). It is a characteristic fungus of nutrient-poor moss- and lichen-rich pine forests but can also be found in other kinds of habitats such as mixed forests, heaths and coastal dunes (with pines). It is mainly threatened by eutrophication and silvicultural intensification.



Tricholoma colossus

Photo Daniel Ghyselinck



Geography

Global distribution: Europe, Asia (Siberia, Turkey, Israel, Korea, China), North America (USA), Oceania (Australia?).

Bibliography: Binyamini (1994), May & Wood (1997), Mao (2000), Fraiture & Walleyn (2005), Ronikier (2005g), Bresinsky & Dörfelt (2008), Sesli & Denchev (2008).

Distribution in Europe: The fungus mainly occurs in the lowlands, occasionally in mountainous regions (above 1200 m in Austria, Bulgaria).

Besides localities indicated on the map, the species is also present in Belarus (Maslovsky 2004).

Areal diagnosis for Europe: Mainly C-Eur. and Medit.; also in Bor., Sarm., Atl. and Alp.; very rare in Therm.; absent from Arct. and Step.

Trophism, hosts and substrates

The species is ectomycorrhizal and lives almost always in symbiosis with *Pinus*. In temperate and boreal regions it is mainly with *P. sylvestris*, in more southern or continental regions also with *Pinus nigra* subsp. *laricio* and subsp. *salzmanni* (both France), *P. nigra* (e.g. Bulgaria, Croatia), *P. nigra* subsp. *pallasiana* (Ukraine) and *P. pinaster* (e.g. Italy, Portugal).



Tricholoma colossus.
Photo Daniel Ghyselinck

Favre (1960) mentions collections under *Pinus mugo* in Switzerland. In France the species was found in symbiosis with *Cedrus*. In Poland, it is even mentioned under *Carpinus* and *Quercus* without conifers, and under *Picea abies* in Estonia.

Habitat

Vegetation: It is a characteristic fungus of nutrient-poor moss- and lichen-rich pine forests, up to the taiga zone. It also occurs in mixed forests (e.g. chestnut-pine in Italy), sometimes in heaths (e.g. Finland), coastal sand dunes with pine (Portugal) and in Mediterranean *Erica* scrubs with pine (France). It occasionally colonizes pine plantations (e.g. Denmark; in Germany under planted *P. nigra*). A finding in an oak-hornbeam forest (without pine?) is reported from Poland. Rarely the fungus was found distinctly synanthropical in arboreta and parks (Ukraine). See also Bresinsky & Dörfelt (2008).

Syntaxa of vegetation: FORESTS: *Dicrano-Pinetum* (incl. *Cladonio-Pinetum* and *Leucobryo-Pinetum*; Germany, Lithuania), *Vaccinio myrtilli-Pinetum*, *Quercus-Carpinetum lathyretosum verni* (= *Galio-Carpinetum lathyretosum*) (both Poland), *Pinetalia sylvestris* (Bulgaria, France, Russia), *Ericion arboreae* (*Pinus nigra* subsp. *salzmannii* and *P. pinaster* stands), *Luzulo-Fagion* (*Pinus nigra* subsp. *laricio* stands) (all France); HEATHS: *Fuberario lignosae-Callunetum* (Italy).

Natura 2000 habitats: Wooded dunes with *Pinus pinca* and/or *Pinus pinaster* (code 2270, Portugal), Western Taiga (code 9010, Estonia, Finland, Latvia, Lithuania, Sweden), Coniferous forests on, or connected to, glaciofluvial eskers (code 9060, Finland, Latvia, Lithuania, Slovenia, Sweden), *Galio-Carpinetum* oak-hornbeam forests (code 9170, Poland), Central European lichen Scots pine forests (code 91T0, Austria), Subalpine and mountain *Pinus uncinata* forests (code 9430, Switzerland), (Sub-)Mediterranean pine forests with endemic black pines (code 9530, France), Mediterranean pine forests with endemic Mesogeian pines (code 9540, France, Italy), Caledonian forest (code 91C0, UK).

Soil requirements: The species often colonizes distinctly dry, acid and oligotrophic soils, especially podzols and regosols, seldom brown soils (e.g. Bulgaria, Poland), rarely it can also grow in damp sites. Geologic substrate: e.g. granite, phyllite (Germany), sandstone (e.g. Italy). In Austria, Bulgaria and Estonia the fungus has also been found on calcareous

soil above limestone. The soils are mainly sandy, seldom silty or clayey (e.g. Bulgaria). Litter layer: absent or thin.

Synanthropy: The species tolerates a moderate anthropogenic influence in terms of planting.

Indicator value: The species is characteristic for natural and near-natural oligotrophic pine forests.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from summer to autumn (July-November).

Frequency

Number of currently known sites: About 220.

Changes in frequency: In Austria there is no record after 1982, in Estonia after 1959 and in Netherlands after 1928. In France, Germany and Sweden, a decrease is reported for the last 100 years, in Lithuania for the last 5 decades, in Portugal a strong decrease is mentioned for the last 10 years. In Spain, no changes have been noticed. In UK an increase in the number of sites is reported.

Threats and conservation

Threats: Sites are mainly threatened by eutrophication and silvicultural intensification.

Status of conservation: The species is red listed in Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Iberian Peninsula (Spain + Portugal), Poland, Latvia, Lithuania, Netherlands, Russia, Sweden, Switzerland and UK. The fungus is protected by law in Lithuania. See also Dahlberg & Croneborg (2003, 2006).

Lyophyllum favrei R. Haller Aar. & R. Haller Suhr

Basidiomycota, Agaricales, Lyophyllaceae

Synonyms: *Calocybe favrei* (R. Haller Aar. & R. Haller Suhr) Bon, *Tricholoma favrei* R. Haller Aar. & R. Haller Suhr

Note 1: The species has been first described as “*Tricholoma Favrei* nov. spec. *Lyophyllum?* *Favrei* nov. spec.”, in *Schweiz. Z. Pilzk.* **27** (9): 132-133 (1949). The authors didn’t ascribe the species to one single genus but, given the publication has been made before the 1st January 1953, the two names are not invalidated (Art. 36.2). The next year, they redescribed the species as “*Lyophyllum Favrei* nov. spec.”, in *Schweiz. Z. Pilzk.* **28** (4): 49-54 + pl. 1 A (1950). This last publication has no nomenclatural value.

Note 2: A f. *ochraceum* R. Haller Aar. (1952, sub „*ochracea*”) has been described [= *L. ochraceum* (R. Haller Aar.) Schwöbel & Reutter (Schwöbel 1969)].

Brief description

A rather large tricholomatoid species, easy to identify with its dark grey-violet cap contrasting with the bright yellow gills, and its flesh becoming reddish or bluish and then blackish when cut. It is very rare and grows almost exclusively in the Alps, where it lives as a saprotroph on humus and litter in deciduous forests, especially under beech (*Fagus sylvatica*). It is mainly threatened by silvicultural intensification.

Geography

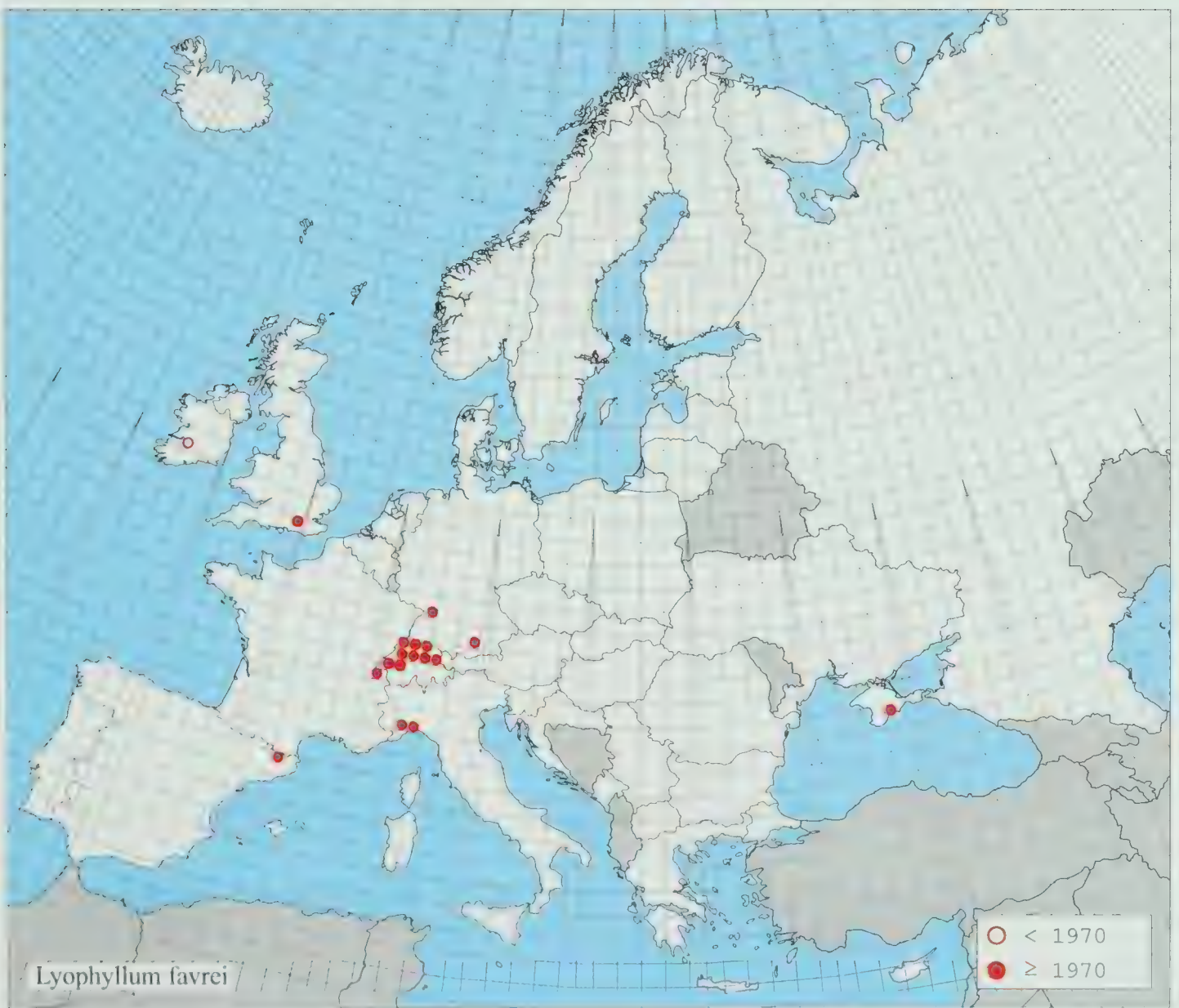
Global distribution: Europe, Asia (Caucasus, Turkey).

Bibliography: Kalamees (1994), Hahn (1995), Sesli & Denchev (2008), Escanez Monferrer (2011).



Lyophyllum favrei

Photo Marco Floriani



Distribution in Europe: The species only occurs in the uplands and in submountainous regions (350-600 m). See also on p. 25.

Besides localities indicated on the map, there is also an old record from south-west Russia, without precise locality.

Areal diagnosis for Europe: Mainly Alp.; very rare in Atl., C-Eur. (S Germany), Therm. (Ukraine) and Medit.; absent from Arct., Bor., Sarm., Step.

Trophism, hosts and substrates

The species is a terricolous saprotroph which decays leaf litter and humus particles of deciduous trees, mainly *Fagus sylvatica*.

Habitat

Vegetation: The fungus is restricted to deciduous forests, most often mesophilic forests with *Fagus sylvatica* (*F. sylvatica* [= *F. moesiaca*] in Ukraine, see Moser 1993). Sometimes, it has also been observed in wet but not temporarily flooded forests in river valleys. In Spain, it has been recently found under *Corylus avellana* and *Quercus humilis* (Escanez Monferrer 2011). See also Hahn (1995).

Syntaxa of vegetation: FORESTS: *Carpinion*, *Fagion*, *Alno-Ulmenalia minoris* (both France).

Natura 2000 habitats: *Asperulo-Fagetum* beech forests (code 9130, France, Switzerland, UK), Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*) (code 91F0, France), Riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *Ulmus minor*, *Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*) (code 91F0, Switzerland).

Soil requirements: The fungus colonizes more or less neutral, fresh to wet mesotrophic to rather eutrophic clayey soils. Soil type: brown soil, alluvial soil. Litter layer: always well developed.

Synanthropy: The fungus always inhabits natural and near-natural forests.

Indicator value: The species is stenoeccious and indicates deciduous forests on rather nutrient-rich soils, with a good water supply.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced in autumn (September-October).

Frequency

Number of currently known sites: About 25.

Changes in frequency: In France, no changes of frequency were announced; for the other countries the situation is insufficiently known.

Threats and conservation

Threats: The sites are mainly threatened by silvicultural intensification (e.g. clear felling, planting of allochthonous trees).

Status of conservation: The species is red listed in France, Switzerland, Ukraine and UK. It is included in the IUCN *Global Fungal Red List Initiative* (see their web-site). See also Dahlberg & Croneborg (2003, 2006).

Entoloma bloxamii (Berk. & Broome) Sacc.

Basidiomycota, Agaricales, Entolomataceae

Misapplied: *E. madidum* ss. auct.

Note 1: Morgado et al. (2013) revised the group of *Entoloma bloxamii*. The study confirmed that *E. madidum* is a different species.

Note 2: A var. *angulata* Cleland, a var. *triste* Boud. and a var. *rubellum* (Scop.) Morgado & Noordel. have been described. After Cléménçon (1985: 179), the var. *triste* is a syn. of *E. madidum*.

Note 3: The f. *caesiolamellatum* Noordeloos & Wölfel (Wölfel & Noordeloos 2001: 187), growing under Lauraceae, has been described from the Canary Islands and has never been found in Europe. It is considered as a distinct species by Morgado et al. (2013).

Brief description

A remarkable entoloma with a tricholomatoid habit and blue colours, becoming brownish with age. It is rather broadly distributed in Europe, but very rare in eastern Europe and in the Mediterranean domain. It lives as a terricolous saprotroph in a wide range of habitats, mainly in extensively used and non-fertilized pastures and meadows. It is mainly threatened by intensification or cessation of grassland management and by eutrophication of sites.

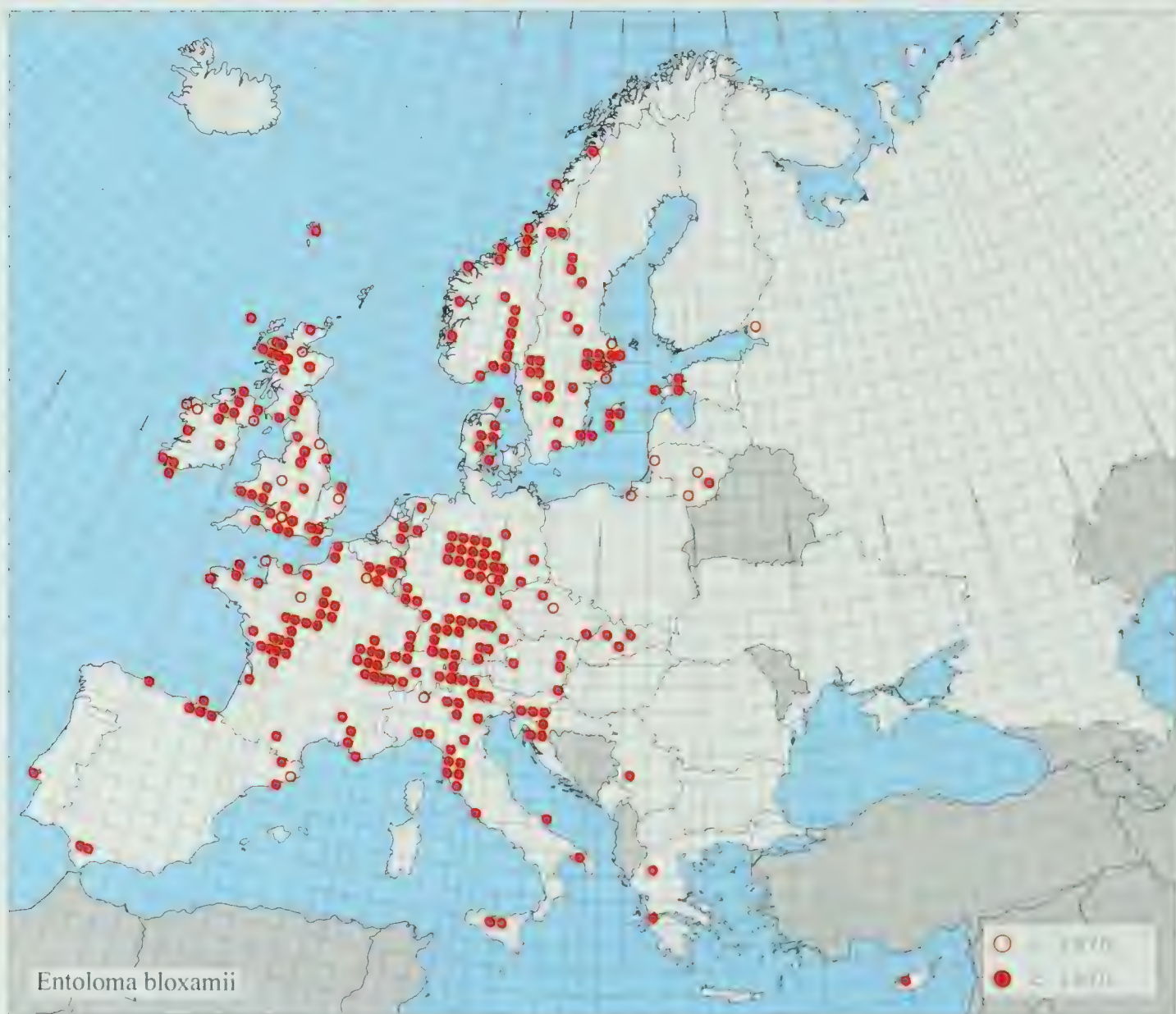
Geography

Global distribution: Europe, Africa (Canary Islands), Asia (China, Taiwan, Japan), North



Entoloma bloxamii

Photo Yves Deneyer



Entoloma bloxamii
Photo Yves Denevet

America (USA?), South America (Brazil), Oceania (Australia?). After a recent study (Morgado et al. 2013), neither *E. bloxamii* nor *E. madidum* occur in North America.

Bibliography: Hesler (1967), Horak (1980), Senn-Irlet (1994), Teng (1996), May & Wood (1997), Rotheroe (1997), McHugh et al. (2001), Wang & Chou (2001), Wölfel & Noordeloos (2001), Fraiture & Walley (2005), Ronikier (2005a), Bresinsky & Dörfelt (2008), Costa Maia & Alves de Carvalho (2010).

Distribution in Europe: The species mainly occurs in the lowlands, occasionally also in mountainous regions (in Italy in alpine grassland up to 2400 m).

Besides localities indicated on the map, the species is also present in Belarus (Maslovsky 2004).

Areal diagnosis for Europe: Mainly Atl., C-Eur. and Alp.; also in Bor. (west), Sarm. (west), Therm. and Medit.; absent from Arct. and Step.

Trophism, hosts and substrates

The fungus lives as a terricolous saprotroph, by decomposing humus particles (also in forests from dead herbaceous species?).

Habitat

Vegetation: The species occurs in a wide range of habitats, mainly in extensively used and non-fertilized and mossy pastures and meadows (also in dunes and on slopes), but also in juniper heaths, alvar shrublands (Estonia), forest meadows, deciduous forests of *Carpinus*, *Quercus* (Hungary), *Castanea*, *Fagus* or *Quercus* (Italy), coniferous forests of *Cupressus* (Italy) or *Picea* (Czech Republic), mixed forests of *Fagus*, *Larix* and *Picea* (Italy), sclerophyllous forests, macchia, and even strongly anthropogenic biotopes such as gardens (e.g. Czech Republic), cemeteries and churchyards (UK). See also Bresinsky & Dörfelt (2008).

Syntaxa of vegetation: FORISTS: *Carpinion betuli* (Germany), *Piceetum muscosum* (Czech Republic), *Quercus petraeae*-*Carpinetum transdanubicum* (Hungary); SHRUBS: *Berberidion*, *Roso-Juniperetum* (both Germany), *Prunetalia* (France); GRASSLANDS: *Xerobrometum*, *Mesobrometum*, *Gentiano-Koelerietum*, *Trinio-Caricetum humilis*, *Pulsatillo-Caricetum humilis*, *Carlino-Caricetum sempervirentis*, *Polygalo-Nardetum*, *Geranio-Trisetetum* (all Germany), *Mesobromion erecti*, *Nardetum alpigenum* (both Germany, Switzerland), *Festuco-Brometea*, *Ononidion striatae*, *Festuco-Seslerietea* (all France).

Natura 2000 habitats: Siliceous alpine and boreal grasslands (code 6150, Slovakia, UK), Alpine and subalpine calcareous grasslands (code 6170, Slovakia, Slovenia, Switzerland, UK), Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (code 6210, Austria, Croatia, Denmark, Estonia, France, Germany, Luxembourg, Netherlands, Republic of Ireland, Slovakia, Sweden, Switzerland, UK), Species-rich *Nardus* grasslands on siliceous substrates in mountain areas (and submountain areas, in Continental Europe) (code 6230, Denmark, Germany, Netherlands, Republic of Ireland, Slovakia, UK), Fennoscandian lowland species-rich dry to mesic grasslands (code 6270, Sweden), *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) (code 6410, UK), Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) (code 6510, Austria, Sweden, UK), Mountain hay meadows (code 6520, Austria, Germany, Slovakia, Sweden, UK), Fennoscandian wooded meadows (code 6530, Sweden), Alkaline fens (code 7230, Netherlands), Fennoscandian hemiboreal natural old broad-leaved deciduous forests (*Quercus*, *Tilia*, *Acer*, *Fraxinus* or *Ulmus*) rich in epiphytes (code 9020, Lithuania, Sweden), Fennoscandian herb-rich forests with *Picea abies* (code 9050, Lithuania), Fennoscandian wooded pastures (code 9070, Sweden), *Quercus suber* forests (code 9330, Spain), *Quercus ilex* and *Quercus rotundifolia* forests (9340, Spain).

Soil requirements: The majority of records originates from distinctly basic and rather dry soils, but the occurrence on neutral and acid as well as on fresh to wet soils has also been proved. Nitrogen content: low. Soil types: alkaline brown soil (terra fusca), renzina, calcareous gley, leptosols and regosols (both Estonia). Geologic substrate: limestone, argillite (Italy)

and pleistocenic sands (e.g. Poland). Grain size: from sand to clay. Litter layer: absent to rather thick (e.g. in forests).

Synanthropy: The species tolerates a wide range of habitats, as regards synanthropy, from natural to distinctly anthropogenic.

Indicator value: The species is a good indicator for poorly manured grasslands on nitrogen-poor soils. After Rotheroe (1997), the species is an indicator of very high quality ancient grassland. It is also listed, with the highest class and score, among the indicators of the Irish grassland quality (McHugh et al. 2001).

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from early summer till late autumn (June-November), in Italy still in December.

Frequency

Number of currently known sites: About 250.

Changes in frequency: In Poland the species has not been recorded since 1917. In France, Germany, Lithuania and Sweden a decrease has been noticed for the last decades. In Estonia, Hungary and Netherlands no changes of frequency were announced. In UK an increase in the number of sites is reported.

Threats and conservation

Threats: It is mainly threatened by intensification or cessation of grassland management and by eutrophication of sites (e.g. due to nitrogen deposition from air pollution). The recommended protective measures are to ban fertiliser application and to manage grass by grazing, preferably by sheep, but also by cattle, rabbit, ... (Rotheroe 2001).

Status of conservation: The species is red listed in Austria, Czech Republic, Denmark, France, Germany, Hungary, Iberian Peninsula (Spain + Portugal), Italy (preliminary list), Lithuania, Luxembourg, Netherlands, Norway, Poland, Slovakia, Sweden, Switzerland and UK. The fungus is protected by law in Croatia, Lithuania and Serbia. See also Dahlberg & Croneborg (2003, 2006).

Cortinarius ionochlorus Maire

Basidiomycota, Agaricales, Cortinariaceae

Synonym: *Cortinarius atrovirens* subsp. *ionochlorus* (Maire) Vizzini & Gasparini (2008).

Note 1: There is a var. *leucophyllus* Malençon in Malençon & Bertault, *Fl. Maroc* I: 482 (1970).

Note 2: Molecular studies have shown that this species is very close to *C. atrovirens*, if not conspecific (see a.o. Garnica et al. 2003: 1165). However, it is still considered as an independent species by *Funga nordica* (Knudsen & Vesterholt 2012), as a subspecies by Vizzini (2008) and as a forma by Garnica et al. (2009). See also Campo (1995).

Brief description

A striking agaric, with an olive green cap, a yellow-green stipe wearing a cortina, lilac lamellae and a smell like black pepper. It is mostly present in south-western Europe, essentially in the Mediterranean domain. It forms ectomycorrhizae mainly with oak species (*Quercus*). It is mostly threatened by silvicultural intensification (e.g. clear felling, planting of allochthonous trees, fertilization).

Geography

Global distribution: Europe, Africa (Morocco).

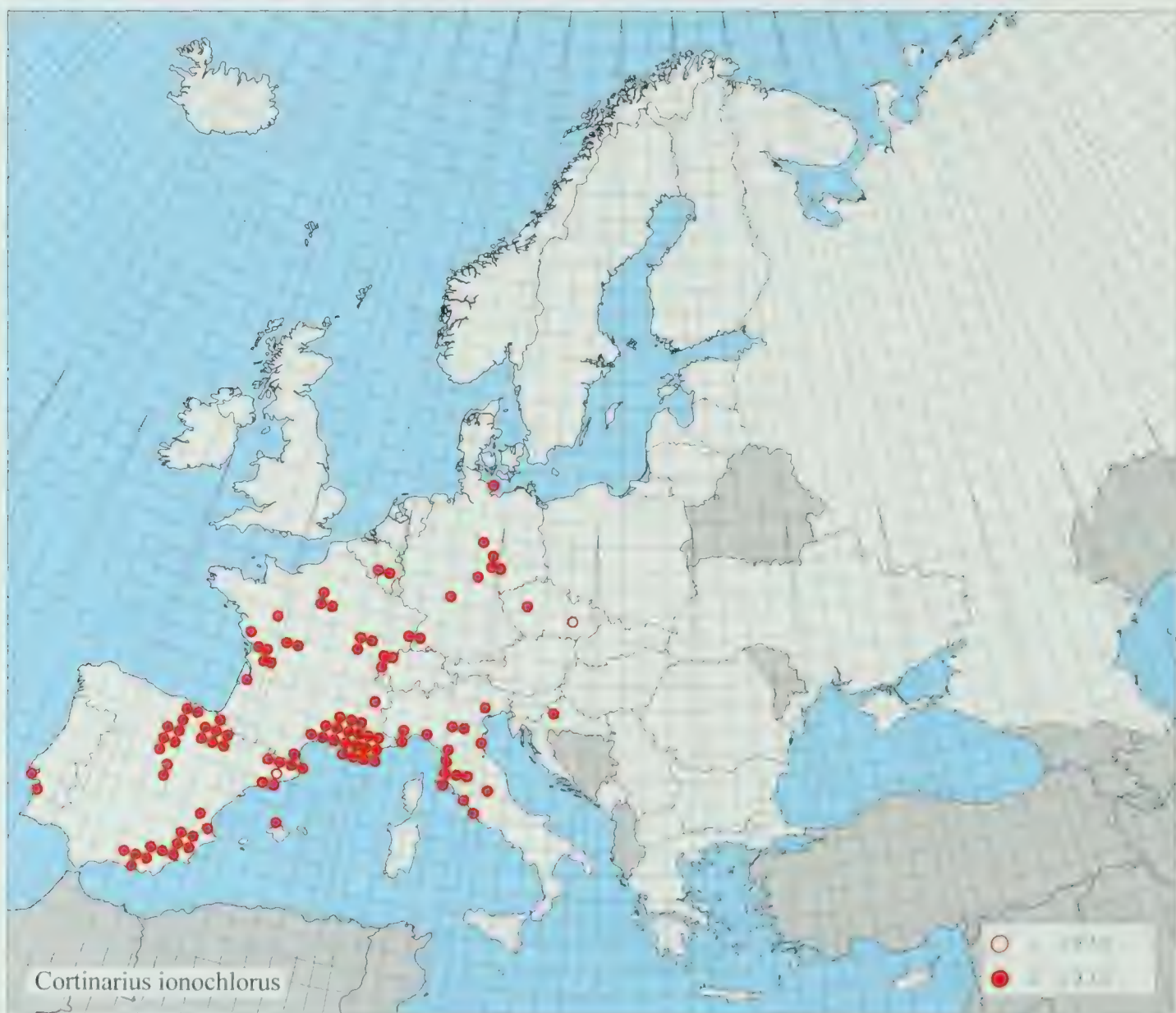
Bibliography: Malençon & Bertault (1970), Fraiture & Walley (2005).

Distribution in Europe: The species mainly occurs in the lowlands, occasionally also in lower mountain regions (e.g. France, Spain).



Cortinarius ionochlorus

Photo Václav Janda



Areal diagnosis for Europe: Mainly Medit.; also Atl., C-Eur. (south), Alp. and Therm.; absent from Arct., Bor., Sarm. and Step.

Trophism, hosts and substrates

It is an ectomycorrhizal fungus living in symbiosis with a few oak species: *Quercus ilex* (Montecchio et al. 2001), *Q. petraea* and perhaps *Q. robur*. In Spain, it has also been recorded as a symbiont of *Pinus*. Outside the Mediterranean domain, it can also grow with *Fagus* (Brandrud et al. 1998).

Habitat

Vegetation: The fungus mainly inhabits more or less thermophilous deciduous (in Croatia with *Ostrya carpinifolia*) and sclerophyllous oak forests, occasionally also mixed forests (*Quercus*, *Pinus*) and macchia with *Quercus ilex*. The range of colonized vegetation types is rather narrow.

Syntaxa of vegetation: FORSIS: *Querceto-Potentilletum albae* (Czech Republic), *Cephalanthero-Fagion*, *Quercetalia ilicis*, *Quercetalia pubescenti-sessiliflorae*, *Carpinion*: *Rubio-Fagetum*, *Aceri monspessulani-Fagetum*, *Rusco-Quercetum petraeae*, *Viburno-lantanae-Quercetum petraeae* (all France), *Quercion ilicis*, *Viburno-Quercetum ilicis ornetosum* (both Italy).

Natura 2000 habitats: Dehesas with evergreen *Quercus* spp. (code 6310, Portugal), *Asperulo-Fagetum* beech forests (code 9130, Germany), Medio-European limestone beech forests of the *Cephalanthero-Fagion* (code 9150, France), Pannonian woods with *Quercus pubescens* (code 91H0, Croatia), *Quercus ilex* and *Quercus rotundifolia* forests (code 9340, France, Italy).

Soil requirements: The fungus is mainly confined to basic soils, but more or less neutral soils are also colonized: limestone, dolostone, dolomitic limestone, sandstone (all Italy). *Geologic substrate:* granite (Spain). In humid regions the species prefers more or less dry soils (e.g. Germany), in more arid regions (e.g. Spain) it was only found on comparatively wet soils (therefore widely constant moisture requirements). *Nitrogen content:* probably always distinctly to moderately low. It seems that the thickness of the litter layer has no influence on the fructification of the species.

Synanthropy: The species only occurs in natural and semi-natural woodlands (macchia as a degraded stage of sclerophyllous forests).

Indicator value: In temperate regions, the species is mainly indicative of thermophilous oak forests.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced rather late in the year (September-October), in Italy till December.

Frequency

Number of currently known sites: About 180.

Changes in frequency: In France no change of frequency has been observed.

Threats and conservation

Threats: Sites are mainly threatened by silvicultural intensification (e.g. clear felling, planting of allochthonous trees, fertilization).

Status of conservation: The species is red listed in Germany and Spain. See also Dahlberg & Croneborg (2003, 2006).

Panaeolus semiovatus (Sowerby: Fr.) S. Lundell & Nannf.
Basidiomycota, Agaricales, ?? (incertae sedis)

Synonyms: *Anellaria semiovata* (Sowerby: Fr.) A. Pearson & Dennis, *Anellaria separata* (L.) P. Karst., *Panaeolus separatus* (L.) Gillet

Misapplied: *Panaeolus fimiputris* (Bull.: Fr.) Quél. ss. auct.

Excluded: *P. phalaenarum* (Fr.) Quél., *P. semiovatus* var. *phalaenarum* (Fr.) Ew. Gerhardt

Note 1: After Gerhardt (1996: 119), the pl. 66 of Bulliard's *Herbier de la France*, which is the iconotypus of *Agaricus fimiputris* Bull.: Fr., could be *Panaeolus papilionaceus*. Therefore, he considers *A. fimiputris* as a nomen dubium and uses *Panaeolus semiovatus* to name the species.

Note 2: Ola'h (1969) separates *Panaeolus fimiputris* from *P. phalaenarum*, but with doubt.

Brief description

A small to medium sized, coprinoid agaric, with a campanulate ivory or cream cap, which does not expand, and a stem provided with a ring. It is widely distributed in Europe and grows as a saprotroph, mainly on dung of domestic animals (cow, horse and sheep).

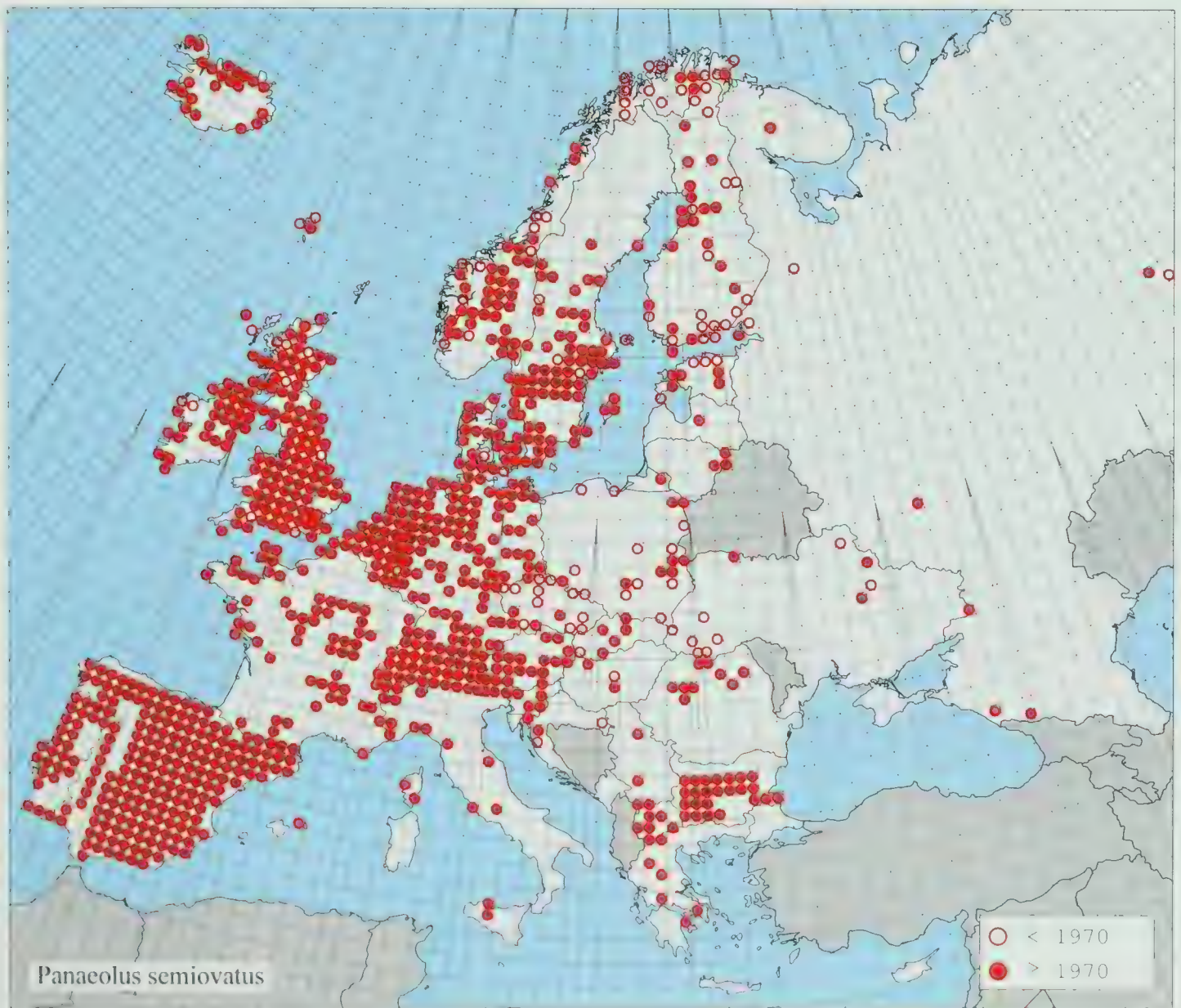
Geography

Global distribution: almost cosmopolitan, Europe, Asia (Georgia, Turkey, Siberia, India, Mongolia, Altai, China, Japan), Africa (Canary Islands, South Africa), North America



Panaeolus semiovatus

Photo Pascal Derboven



(Greenland, Canada, USA, Mexico), Central America (Panama), South America (Columbia, Venezuela, Argentina, Falkland Islands), Oceania (Hawaii, Australia, New Zealand).

Bibliography: Doidge (1950), Dennis (1971), Skirgiello (1972b), Lange (1974), Wildpret & Beltran (1974), Horak (1979), Hongo (1986), Llistosella & Aguasca (1990), Merlin & Allen (1993), Nauta & Vellinga (1995), Gerhardt (1996), May & Wood (1997), Franco-Molano & Uribe-Calle (2000), Mao (2000), Segedin & Pennycook (2001), Quinónez-Martínez & Garza-Ocañas (2003), Fraiture & Walley (2005), Borgen et al. (2006), Bresinsky & Dörfelt (2008), Jamoni (2008), Sesli & Denchev (2008), Gorbunova (2010), Watling & Richardson (2010), Gvritishvili et al. (2012), Iturriaga & Minter (2012).

Distribution in Europe: The species mainly occurs from the lowlands to mountainous and subalpine regions. In Austria it was also found in the alpine zone up to 2500 m. Lange (1974) gives the altitude range of the species in several European countries. Favre (1955) observed the species up to an altitude of 2819 m.

Areal diagnosis for Europe: Mainly Atl., C-Eur., Alp. and Medit.; also Arct., Bor., Sarm. and Therm.; very rare in Step.

Trophism, hosts and substrates

A saprotrophic fungus colonizing dung of domestic (cow, horse, donkey and sheep) and



Panaeolus semiovatus

Photo Yves Deneyer

wild herbivores (wild boar, fide Bresinsky & Dörfelt 2008). In Sweden also reported on fertile soils (dung already completely decayed or overlooked?).

Habitat

Vegetation: The fungus mainly occurs in anthropogenic grasslands (meadows, also fertilized pastures), in nutrient-poor semi-natural grasslands (e.g. Netherlands, Russia) and in steppes (Ukraine, Russia), but it has also been observed in deciduous forests (e.g. *Acer campestre*, *Alnus*, *Carpinus betulus*, *C. orientalis*, *Castanea*, *Fraxinus*, *Populus tremula*, *Quercus* spp.), sclerophyllous forests (*Quercus ilex*) and coniferous forests because of grazing in these habitats. The species was also found in parks, along grassy roadsides and forest roads (Bulgaria, Poland). See also Nauta & Vellinga (1995), Bresinsky & Dörfelt (2008).

Syntaxa of vegetation: FORESTS: *Alnion glutinosae* (Germany), *Alnetum glutinosae* (Hungary), *Quercetum trojanae* (Montenegro); HALOPHYTIC VEGETATION: *Puccinellion maritimae*, *Juncetum gerardii* (both Germany); GRASSLANDS: *Polygalo-Nardetum*, *Arrhenatherion elatioris*, *Geranio-Trisetetum*, *Lolio-Cynosuretum*, *Agroporo-Rumicion* (all Germany), *Plantaginetea majoris* (Netherlands), *Cynosurion*, *Poion alpinae* (both Switzerland), *Cynodonti-Festucetum* (Hungary), *Festuco-Agrostetum tenuis*, *Scorzonero roseae-Festucetum nigricantis* (both Romania); HEATHLIKE VEGETATION: *Salicetum herbaceae* (Switzerland)

Natura 2000 habitats: Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) (code 1330, Denmark, Germany), Fixed coastal dunes with herbaceous vegetation (grey dunes) (code 2130, Denmark, Netherlands), Decalcified fixed dunes with *Empetrum nigrum* (code 2140, Denmark), Atlantic decalcified fixed dunes (*Calluno-Ulicetea*) (code 2150, Netherlands), Dry sand heaths with *Calluna* and *Genista* (code 2310, Netherlands), European dry heaths (code 4030, Denmark, Netherlands), Oro-Iberian *Festuca indigesta* grasslands (code 6160, Portugal), Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brom-*

talia) (code 6210 Denmark, Estonia, Slovakia, Sweden), Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea* (code 6220, Portugal, Slovakia), Species-rich *Nardus* grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe) (code 6230, Denmark, Germany, Netherlands), Pannonic sand steppes (code 6260, Hungary), Fennoscandian lowland species-rich dry to mesic grasslands (code 6270, Latvia, Sweden), Ponto-Sarmatic steppes (code 62C0, Ukraine), Dehesas with evergreen *Quercus* spp. (code 6310, Portugal), *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) (code 6410, Denmark, Ukraine), Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) (code 6510, Czech Republic, Netherlands, Ukraine), Mountain hay meadows (code 6520, Austria, Bulgaria, Macedonia, Montenegro, Ukraine), Alkaline fens (code 7230, Denmark), Fennoscandian wooded pastures (code 9070, Finland, Sweden), *Galio-Carpinetum* oak hornbeam forests (code 9170, Ukraine), Eastern white oak woods (code 91AA, Greece), Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*) (code 91E0, Ukraine), Euro-Siberian steppic woods with *Quercus* spp. (code 91H0, Ukraine), Holy Cross fir forest (*Abietetum polonicum*) (code 91P0, Ukraine), Central European lichen Scots pine forests (code 91T0, Ukraine), Sarmatic steppe pine forest (*Cytiso-Pinetalia*) (code 91U0, Ukraine), Moesian beech forests (code 91W0, Greece), *Castanea sativa* woods (code 9260, Italy), *Quercus ilex* and *Quercus rotundifolia* forests (code 9340, Italy), Acidophilous *Picea* forests of the mountain to alpine levels (*Vaccinio-Piceetea*) (code 9410, Bulgaria, Ukraine).

Soil requirements: Since the fungus is coprophilous, wetness is the most important soil character, because it influences the water content of dung. The species is reported on dung on brown luvic and podzolic soils and on sand.

Synanthropy: The species occurs in natural (e.g. Hungary, Spain, Italy, Ukraine, Russia) as well as in strongly anthropogenic habitats.

Indicator value: A specific indicator value is not known.

Occurrence of fruitbodies (phenology)

Basidiocarps are mainly produced from early summer till autumn (May-October), in periods of high precipitation or in habitats with wet soils and high humidity. In France, records exist from January to December.

Frequency

Number of currently known sites: About 500.

Changes in frequency: In the Czech Republic, Germany and the western part of Poland, a decrease has been noticed for the last 40 years. In Netherlands, the species has been declining between 1950 and 1980 but, since then, the number of sites increased again, perhaps due to the use of domestic animals (cows, horses) for the management of natural reserves (Nauta & Vellinga 1995).

Threats and conservation

Threats: Sites are threatened by agricultural intensification (e.g. pesticides) and afforestation.

Status of conservation: The species is red listed in France, Germany, Poland and Serbia. It is protected by law in Serbia.

Hygrocybe calyptriformis (Berk.) Fayod

Basidiomycota, Agaricales, Hygrophoraceae

Synonyms: *Agaricus calyptriformis* [sub “calyptraeformis”] Berk., *Hygrophorus calyptriformis* [sub “calyptraeformis”] (Berk.) Berk. & Broome, *Porpolomopsis calyptriformis* (Berk.) Bresinsky, *Humidicutis calyptriformis* (Berk.) Vizzini & Ercole

Misapplied: *Hygrocybe amoena* (Lasch) and *Hygrophorus amoenus* (Lasch) ss. auct. plur. (nomen dubium). The basionym of those two names, *Agaricus amoenus* Lasch, is probably a later homonym of *Agaricus amoenus* Weinm. in Fr., El. Fung. 1: 38 1828).

Note 1: The confusion with *H. amoena* has been introduced since the original description, in which Berkeley (1838: 198-199) mentions “*Ag. conicus* α *amoenus*, Lasch in Linnaea, vol. iii. p. 380” [1828] as a synonym of the *A. calyptraeformis* he’s describing as a new species. However, based on the description and comments given by Berkeley, it seems probable that the two taxa are not identical and that Berkeley’s collection is the fungus called “*calyptriformis*” by modern authors. In conclusion, it is probably better to reject the name “*Hygrophorus amoenus*” as a *nomen confusum*.

Note 2: In 1838, the *Notices of British Fungi* were still published by Berkeley alone and Broome should not be cited as co-author of the basionym (*Agaricus calyptriformis*).

Note 3: A var. *niveus* has been described by Cooke (*Handb. Brit. Fung.*, 2nd ed., 1883: 303).

Note 4: A var. *domingensis* has been described from the Dominican Republic (Cantrell & Lodge 2000).

Note 5: Bresinsky (2008) places the species outside the genus *Hygrocybe* and preliminary results of molecular analysis (Babos et al. 2011) confirm that hypothesis. Bresinsky describes the new genus *Porpolomopsis* to accommodate the species. Vizzini & Ercole (2011) prefer to combine the species in the genus *Humidicutis* (Singer).



Hygrocybe calyptriformis

Photo Jean-Paul Maurice

Brief description

A striking agaric, with a conical pinkish cap and a whitish to pinkish stem. It is mainly present in the Atlantic (esp. UK) and Alpine domains and lives on humus, as a terricolous saprotroph. It mainly occurs in unfertilized meadows and pastures but has also been observed in other biotopes (dunes, forests, calcareous fens, heaths). It is mainly threatened by eutrophication and by cessation of grassland management.

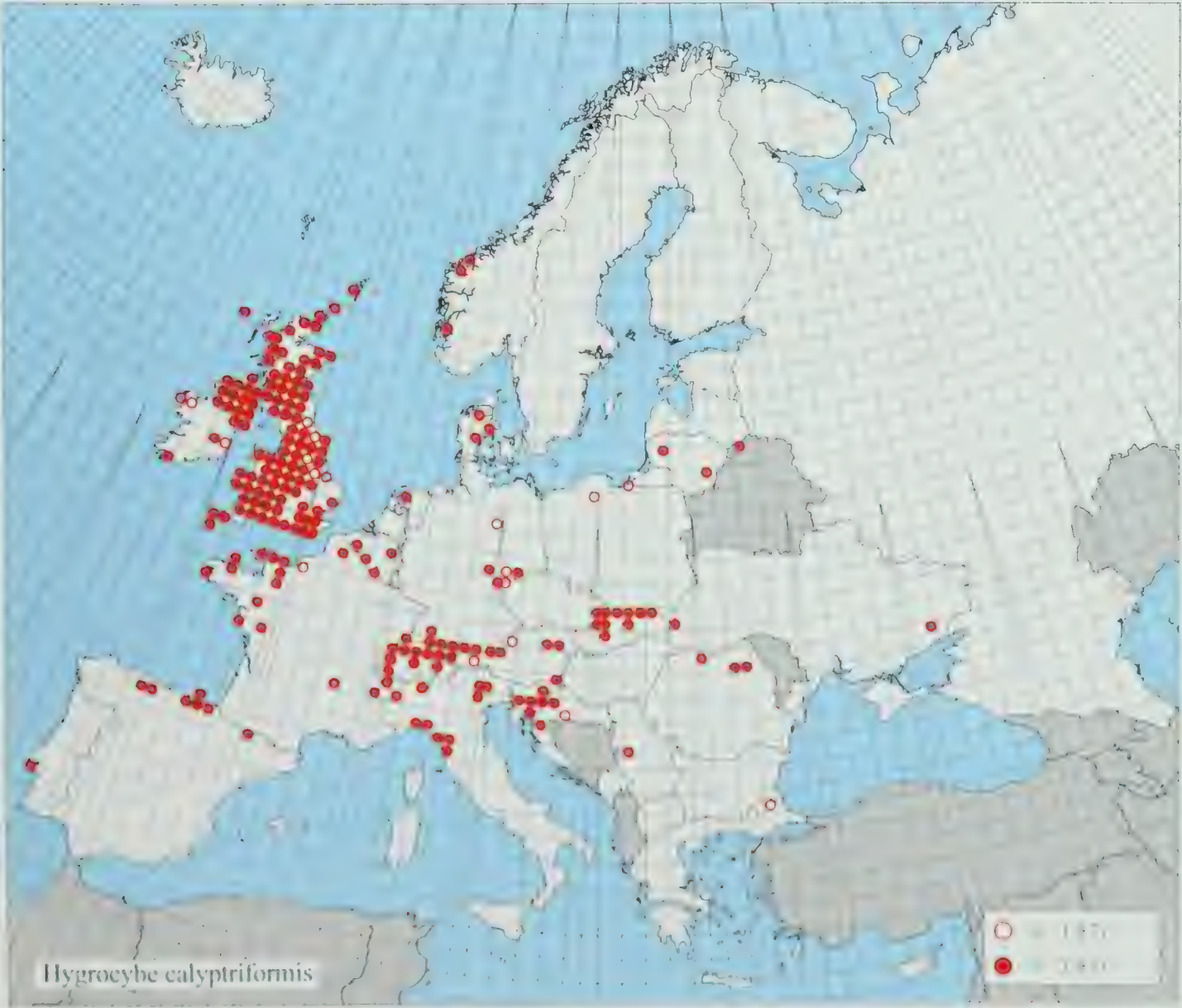
Geography

Global distribution: Europe, Asia (Turkey, Russia, Korea, China, Japan), North America (USA), Central America (Dominican Republic).

Bibliography: Hesler & Smith (1963), Brandt-Pedersen (1980), Rald (1985), Bessette et al. (1997), Rotheroe (1997), Groger (1998), Kovalenko (1999), Jordal & Holtan (2000), Mao (2000), Fraiture & Walley (2005), Ronikier (2005b), Siller et al. (2005), Bresinsky & Dörfelt (2008), Sesli & Denchev (2008), Boertmann (2010), Minter & Perdomo (2012).

Distribution in Europe: The species occurs from lowlands to subalpine regions (e.g. Slovenia, UK), where it has been found up to 1800 m (Bresinsky 2008).

Besides localities indicated on the map, the species has also been observed in Estonia and





Hygrocybe calyptriformis
Photo Jean-Paul Maurice

on the Faroe Islands (Bresinsky 2008; the latter region also mentioned by Boertman 2010). *Areal diagnosis for Europe*: Mainly Atl. (esp. UK) and Alp.; also C-Eur.; very rare in Sarm., Therm., Medit. and Step. (an isolated record in Ukraine); absent from Arct. and Bor.

Trophism, hosts and substrates

The species is probably a terricolous saprotroph which decomposes humus particles. However, observations made on species of the group of *Hygrocybe conica* seem to show they can develop some kind of mycorrhizal association with seed plants (Halbwachs et al. 2013). On the other hand, Boertmann (2010: 25) evokes the hypothesis of a possible commensalism between *Hygrocybe* species and mosses.

Habitat

Vegetation: The fungus is recorded from different kinds of biotopes. Most often it was found in extensively used, unfertilized grasslands (meadows and pastures). The species also occurs in dunes, forests (e.g. *Alnus*, *Fraxinus* and *Fagus* forests, sclerophyllous forests), grazed open forests (dehesas), oak plantation (Ukraine), olive-tree plantation (Italy), calcareous fens, heaths and scrublands. Noteworthy is a certain preference for anthropogenic biotopes especially in UK (lawns, churchyards, cemeteries and parks). See also Dietrich & Krause (1992), Evans (2003), Bresinsky (2008) and Bresinsky & Dörfelt (2008).

Syntaxa of vegetation: FORESTS: *Alnetum incanae* (Poland, Germany), *Corvilo-Fraxinetalia* (France), *Corvilo-Populion tremulae* (Slovakia); SHRUBS: *Prunetalia* (France); HEATHS: *Genistion pilosae* (France), *Nardo-Caulinetum* (Hungary); GRASSLANDS: *Astrantio-Trisetetum flavescentis*, *Geranio-Trisetetum*, *Meo-Festucetum rubrae* (all Germany), *Polygalo-Nardetum* (Germany, Slovakia), *Ononidion striatae*, *Koelerion* (both France) *Festuco-Brometea*, *Festuco-Seslerietea* (both France, Slovakia), *Festuceto rubrae-Agrostidetum*, *Viola caninae-Nardetum* (Romania, Slovakia)

Natura 2000 habitats: Fixed coastal dunes with herbaceous vegetation (grey dunes) (code 2130, France), Machairs (code 21A0, Republic of Ireland), Wooded dunes with *Pinus pinea* and/or *Pinus pinaster* (code 2270

Portugal), Siliceous alpine and boreal grasslands (code 6150, Slovakia, UK), Alpine and subalpine calcareous grasslands (code 6170, France, Slovakia, Slovenia, UK), Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (code 6210, Bulgaria, Croatia, Denmark, France, Republic of Ireland, Serbia, Slovakia, Switzerland, UK), Species-rich *Nardus* grasslands on siliceous substrates in mountain areas (and submountain areas, in Continental Europe) (code 6230, Denmark, Germany, Republic of Ireland, Netherlands, Slovakia, Switzerland, UK), Eastern sub-Mediterranean dry grasslands (code 62A0, Croatia), Dehesas with evergreen *Quercus* spp. (code 6310, Portugal), Calcareous fens with *Carex lasiocarpa* (code 6410, Czech Republic, UK), Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) (code 6510, UK), Mountain hay meadows (code 6520, Croatia, Germany, Poland, Romania, Slovakia, UK), Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*) (code 91E0, Poland), Galicio-Portuguese oak woods with *Quercus robur* and *Quercus pyrenaica* (code 9230, Spain), *Cupressus* forests (*Acero-Cupression*) (code 9290, Portugal).

Soil requirements: The species is rather euryoecious. It tolerates a wide range of pH-values from acid to basic, of water supply from rather dry to damp, and of nitrogen content from low to moderately high. Soil types: brown soil, rendzina (Germany). Geologic substrate: limestone (e.g. Slovenia), crystalline schist (Bulgaria). The fungus avoids sandy soils and sites with a thick litter layer.

Synanthropy: The species mainly occurs in semi-natural and distinctly anthropogenic grasslands, seldom in natural biotopes (e.g. forests, dunes).

Indicator value: The fungus indicates more or less open biotopes, often rich in plant species and rather poor in nutrients.

Occurrence of fruitbodies (phenology)

Basidiocarps are mainly produced from summer till autumn (June-November), in UK still in December.

Frequency

Number of currently known sites: About 600, including 450 in UK.

Changes in frequency: In Lithuania no records are mentioned after 1974. In Czech Republic, France, Germany and Slovakia a decrease has been noticed during the last decades. In Poland no change of frequency is mentioned. In UK an increase in the number of sites is reported.

Threats and conservation

Threats: The species is mainly threatened by the intensification or the cessation of grassland management and by eutrophication of sites (e.g. due to nitrogen deposition from air pollution).

Status of conservation: The species is red listed in Austria, Belgium (regional red list), Bulgaria, Czech Republic, Denmark, France, Germany, Hungary, Iberian Peninsula (Spain + Portugal), Italy (preliminary list), Poland, Serbia, Slovakia, Switzerland and UK. It is protected by law in Croatia, Hungary, Serbia and UK. See also Dahlberg & Croneborg (2003, 2006).

Hygrocybe laeta (Pers.: Fr.) P. Kumm.

Basidiomycota, Agaricales, Hygrophoraceae

Synonyms: *Hygrophorus laetus* (Pers.: Fr.) Fr., *Gliophorus laetus* (Pers.: Fr.) Herink, *Hygrophorus houghtonii* Berk. & Broome

Excluded: *Hygrocybe laeta* var. *luteolaeta* (Arnolds) Bon [= *H. vitellina* (Fr.) P. Karst.].

Note 1: Several forms and varieties have been described, a.o. the var. *flava* Boertm.

Note 2: Bresinsky (2008) places the species outside the genus *Hygrocybe* and preliminary results of molecular analysis (Babos et al. 2011) confirm that hypothesis.

Brief description

A small to medium sized agaric, with viscose and more or less orange cap and stem (sometimes with an olivaceous tinge), translucently striate cap and decurrent gills. It is largely distributed in Europe, mainly in the Atlantic, Central European, Alpine and Boreal domains. It lives as a terricolous saprotroph, in a wide range of habitats, mostly in unfertilized meadows and pastures. It is mainly threatened by eutrophication and by cessation of grassland management.

Geography

Global distribution: Europe, Asia (Georgia, Siberia, Korea, China, Japan, Ceylon, Malaysia), Africa (Atlas Mountains), North America (Greenland, Canada, USA), Central America (Costa Rica, Puerto Rico, Dominican Republic), South America (Colombia, Argentina, Chile), Oceania (New Guinea). The mention from Australia is probably a mistake for *H. viscidibrunnea*.



Hygrocybe laeta

Photo Rüdiger Walther

Bibliography: Hesler & Smith (1963), Hongo (1973), Bird & Grund (1979), Rald (1985), Nauta & Vellinga (1995), Bessette et al. (1997), May & Wood (1997), Rotheroe (1997), Kovalenko (1999), Mao (2000), Colzani & Della Rovere (2003), Fraiture & Walley (2005), Robin (2005), Young (2005), Borgen et al. (2006), Ripková et al. (2007), Bresinsky & Dörfelt (2008), Jamoni (2008), Franco-Molano et al. (2010), Cantrell et al. (2012), Gvritishvili et al. (2012), Minter & Perdomo (2012), Niveiro & Albertó (2012).

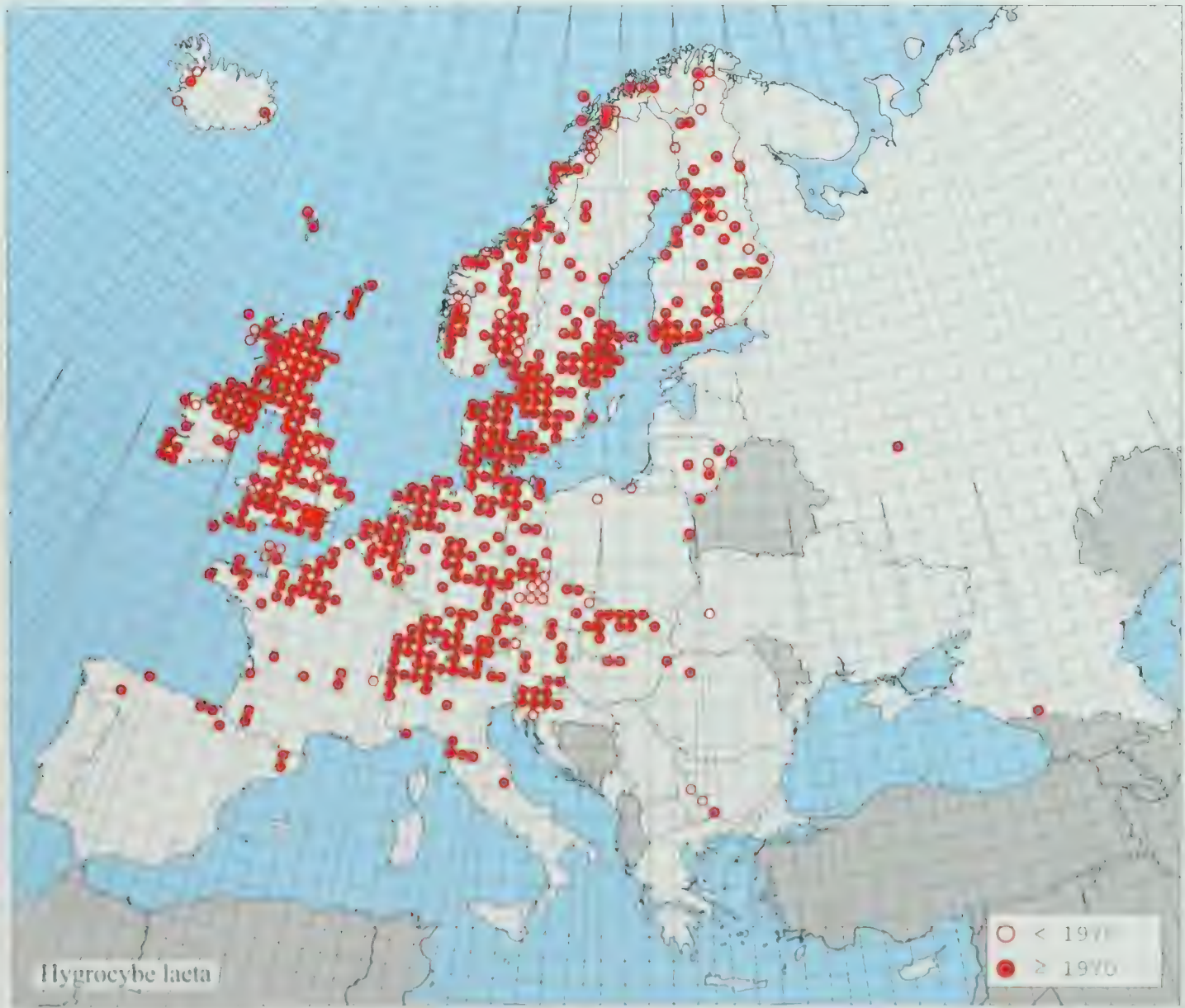
Distribution in Europe: The species mainly occurs in the lowlands, occasionally also in mountainous regions (e.g. Spain; in Bulgaria and France also above 1200 m). Jamoni (2008) mentions observations of the var. *flava* in Alpine and Arctic zones.

Besides localities indicated on the map, the species has also been mentioned from northern Russia and from Estonia (Bresinsky 2008, Boertmann 2010).

Areal diagnosis for Europe: Mainly Atl., C-Eur. and Alp.; also Bor.; very rare in Arct. (?), Sarm., Therm. and Medit.; absent from Step.

Trophism, hosts and substrates

The fungus lives as a terricolous saprotroph and decays humus particles and litter (also *Picea* needles, in Iceland). It is rather often observed between mosses. See also the “trophism” paragraph under *Hygrocybe calyptriformis*.



Habitat

Vegetation: The species has been observed in a very wide range of habitats. Most of the records concern unfertilized and extensively used meadows and pastures. The species seldom occurs in grasslands on nutrient-rich soils. It is also reported in different types of deciduous forests, coniferous forests and plantations (e.g. *Cryptomeria japonica* in Croatia, *Pinus nigra* in Hungary), mixed forests, forest edges, heaths, white and grey dunes, fens and bogs. In Iceland the fungus has been found in grassy snow beds and in spruce woodlands. The species occurs also rather rarely in gardens and cemeteries (mainly UK). The var. *flava* mainly grows in Arctic and Alpine environment, in pastures and in grassy dwarf willow carpets (Jamoni 2008, Boertmann 2010). See also Bresinsky (2008), Bresinsky & Dörfelt (2008).

Syntaxa of vegetation: FORESTS: *Carpinion betuli*, *Quercion pubescenti-petraeae*, *Vaccinio uliginosi-Betuletum pubescentis*, *Dicrano-Pinion*, *Leucobryo-Pinetum* (all Germany), *Quercetum petraeae-cerris*, *Luzulo-Quercetum* (both Hungary); SHRUBS: *Roso-Juniperetum*, *Calluno-Sarothamnetum* (both Germany); HEATHS: *Nardo-Callunetea* (Netherlands); GRASSLANDS: *Ammophiletea arenariae*, *Corynephorion canescentis*, *Nardetum alpigenum*, *Thymo-Festucetum*, *Violion caninae*, *Juncion squarrosi*, *Arrhenatherion elatioris*, *Geranio-Trisetetum*, *Festuco-Cynosuretum*, *Lolio-Cynosuretum*, *Juncio-Molinietum caeruleae* (all Germany), *Nardion*, *Polygalo-Nardetum* (both Germany, Slovakia), *Juncetum squarrosi*, *Festuco-Galietum veri*, *Thero-Airion* (Netherlands), *Nardo-Callunetum* (Hungary), *Festuco rubrae-Agrostetum tenuis* (Romania).

Natura 2000 habitats: Pannonic salt steppes and salt marshes (code 1530, Hungary), European dry heaths (code 4030, Denmark, Estonia, Germany, Italy, Netherlands), Alpine and Boreal heaths (code 4060, Norway), Siliceous alpine and boreal grasslands (code 6150, Slovakia), Alpine and subalpine calcareous grasslands (code 6170, Slovakia), Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (code 6210, Slovakia), Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas (and submountain areas in Continental Europe) (code 6230, Denmark, Germany, Netherlands, Norway, Slovakia), Sub-Pannonic steppic grasslands (code 6240, Hungary, Slovakia), Pannonic sand steppes (code 6260, Hungary), Fennoscandian lowland species-rich dry to mesic grasslands (code 6270, Finland, Norway, Sweden), *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) (code 6410, Germany), Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) (code 6510, Czech Republic), Coniferous forests on, or connected to, glaciofluvial eskers (code 9060, Finland), Fennoscandian wooded pastures (code 9070, Sweden), *Luzulo-Fagetum* beech forests (code 9110, Hungary), Sub-Atlantic and mediterranean oak or oak-hornbeam forests of the *Carpinion betuli* (code 9160, Croatia), Pannonian-Balkan turkey oak - sessile oak forests (code 91M0, Hungary), Central European lichen Scots pine forests (code 9110, Germany).

Soil requirements: The species prefers more or less acid and nutrient-poor soils, but tolerates even basic and eutrophic ones. Soil moisture: distinctly wet to rather dry soils. Soil types: brown soil, pseudogley, ranker, regosol and peaty soils. Geologic substrate: e.g. granite (Bulgaria), limestone (Slovenia), quartz, sandstone and schist (e.g. Czech Republic). Grain size: mostly clay. Litter layer: thin. See also Bresinsky (2008).

Synanthropy: The species mainly occurs in natural and semi-natural habitats (e.g. forests, grasslands), only rather seldom in anthropogenic biotopes.

Indicator value: The fungus mainly indicates open vegetation types on more or less acid and nutrient-poor soils.

Occurrence of fruitbodies (phenology)

Basidiocarps are mainly produced from summer till late autumn (July-November), in UK still in December.

Frequency

Number of currently known sites: About 600.

Changes in frequency: In Czech Republic, France, Germany and Netherlands a decrease has been noticed during the last decades (but, for Netherlands, also an increase in dune areas since 1990). In Finland, Hungary and Slovenia no changes of frequency are announced.

Threats and conservation

Threats: The species is mainly threatened by intensification or cessation of grassland management and by eutrophication of sites (e.g. due to nitrogen deposition from air pollution).

Status of conservation: The species is red listed in Belgium (regional red list), Czech Republic, France, Germany, Hungary, Netherlands and Switzerland.

Hygrophorus marzuolus (Fr.: Fr.) Bres.

Basidiomycota, Agaricales, Hygrophoraceae

Synonyms: *Camarophyllus marzuolus* (Fr.: Fr.) Ricken, *Limacium marzuolus* (Fr.: Fr.) Velen.

Note 1: The epithet has been sanctioned by Fries, sub *Clitocybe marzuolus*.

Note 2: There is a var. *albus* A. Pouchet.

Brief description

A medium sized agaric with a stocky habit, more or less dark grey cap and stem and whitish gills. It mostly grows in the Central European and Alpine domains. It forms ectomycorrhizae with various coniferous trees, especially fir (*Abies alba*) and spruce (*Picea abies*) and mainly appears in mountainous regions, on neutral to calcareous soils. It is a spring fungus and an edible species. It is mainly threatened by silvicultural intensification and soil acidification.

Geography

Global distribution: Europe, Asia (Russia, Pakistan), Africa (Morocco, Turkey), North America (USA).

Bibliography: Kraft (1958, 1959), Hesler & Smith (1963), Dörffelt (1971), Lange (1974), Malençon & Bertault (1975), Kovalenko (1999), Fraiture & Walley (2005), Razaq & Shahzad (2005), Bresinsky & Dörffelt (2008), Sesli & Denchev (2008).

Distribution in Europe: The species mainly occurs in mountainous regions (e.g. in Austria, Macedonia and Serbia also above 1200 m), seldom in the lowlands (e.g. Spain). See p. 25.



Hygrophorus marzuolus

Photo Yves Deneyer

After Bresinsky (2008), the species has also been observed in Bosnia.

As already pointed by Kraft (1958), the distribution of the species fits well with the natural area of its main host, *Abies alba*; see the distribution map on p. 181. The localities outside that area often correspond, either with plantations of *Abies alba* or *Picea abies* (e.g. Belgium) or with natural stands of gymnosperms (e.g. *Abies borisii-regis*, *Pinus sylvestris*).

Areal diagnosis for Europe: Mainly C-Eur. (south) and Alp.; also Therm. and Medit.; very rare in Atl.; absent from Arct., Bor., Sarm. and Step.

Trophism, hosts and substrates

The fungus mainly forms ectomycorrhizae with coniferous trees of the family Pinaceae, most often with *Abies* (*A. alba*; *A. borisii-regis* in Macedonia) and *Picea abies*, but also with *Pinus* (*P. nigra*, *P. sylvestris* and *P. mugo* incl. *P. uncinata*) and *Pseudotsuga* (France). Only relatively seldom the fungus was found in symbiosis with Fagaceae, especially *Fagus sylvatica*, in southern Europe also with *Castanea sativa*, *Quercus cerris* and *Q. petraea*. See also Bresinsky (2008).



Habitat

Vegetation: The species mainly inhabits mountain fir and spruce forests, seldom also coniferous plantations, mixed and deciduous forests as beech and oak forests. In Czech Republic, it is considered as related to the *Clitocybe brumali-Phellodonetum nigri*. According to Kraft (1958), it colonizes dark, cold and humid biotopes. See also Dörfelt (1971) and Bresinsky & Dörfelt (2008).

Syntaxa of vegetation: FORSIS: *Galio odorati-Fagetum*, *Carici-Fagetum*, *Galio rotundifolii-Abietenion*, *Piceion abietis* (all Germany), *Dicrano-Pinetum silvestris*, *Piceo-Fagetum* (both Romania), *Piceo-Pinetum silvestris*, *Piceetum excelsae croaticum*, *Piceetum excelsae montanum* (all Montenegro), *Digitali viridiflorae-Pinetum peuces* (Macedonia).

Natura 2000 habitats: *Luzulo-Fagetum* beech forests (code 9110, Croatia, Czech Republic, Slovakia), *Asperulo-Fagetum* beech forests (code 9130, Austria, Germany, Slovakia), Medio-European limestone beech forests of the *Cephalanthero-Fagion* (code 9150, Germany, Slovakia), *Galio-Carpinetum* oak-hornbeam forests (code 9170, Croatia), *Castanea sativa* woods (code 9260, Italy), Hellenic beech forests with *Abies borisii-regis* (code 9270, Greece), Acidophilous *Picea* forests of the mountain to alpine levels (*Vaccinio-Piceetea*) (code 9410, Germany, Montenegro), Mediterranean pine forests with endemic Mesogean pines (code 9540, Greece), High oro-Mediterranean pine forests (code 95A0, Macedonia).

Soil requirements: More or less basic (but often superficially acidified by litter decomposition) to neutral soils. Soil types: a.o. brown soil, podzol (e.g. Romania) and rendzina. The species avoids strongly acid (pH below 3.5) and eutrophic soils. Geologic substrate: e.g. granite (Macedonia), marble, schist (both Bulgaria), limestone. Soil moisture: rather dry to wet soils. Grain size: from sand to clay. Litter layer: from absent to thick. See also the synthesis presented by Kraft (1958).

Synanthropy: The fungus almost exclusively occurs in natural and near-natural forests (seldom in plantations).

Indicator value: The species indicates not too strongly acidified forests, in Central Europe mainly mountain ones.

Occurrence of fruitbodies (phenology)

Typically, fruitbodies are clustered and appear in early spring, sometimes under the snow (often February-March, in higher mountains and in cold springs also April-May, in the Mediterranean region also from December onwards). In Serbia a period from March till June was reported. Collections made in autumn probably belong to *Hygrophorus atramentosus*. See also the synthesis presented by Kraft (1958). Intensity of fructification strongly varies from year to year (masses of fruit bodies in some years and no fructifications in many others, probably due to different weather conditions).

Frequency

Number of currently known sites: About 250.

Changes in frequency: In Austria, Czech Republic, Germany, Macedonia and Slovakia a decrease has been noticed during the last decades. In France and Spain no change of frequency was announced.

Threats and conservation

Threats: Sites are mainly threatened by silvicultural intensification (e.g. clear-cuttings,

planting of allochthonous trees, fertilization), but also by strong acidification due to air pollution.

Status of conservation: The species is red listed in Austria, Croatia, Czech Republic, France, Germany, Hungary, Macedonia (preliminary list), Montenegro, Romania, Serbia, Slovakia and Switzerland. It is protected by law in Croatia, Germany, Serbia and Slovakia. In the past the species was sold on markets in Austria, France, Germany, Italy and Switzerland (nowadays this is prohibited). The species is included in the IUCN *Global Fungal Red List Initiative* (see their web-site).

Hygrophorus purpurascens (Alb. & Schwein.: Fr.) Fr.

Basidiomycota, Agaricales, Hygrophoraceae

Synonym: *Limacium purpurascens* (Alb. & Schwein.: Fr.) P. Kumm.

Brief description

A medium sized to rather large agaric, with a stocky habit, pinkish fruitbodies with purple brown spots and fibrils, and whitish then pink to purplish gills. It is a rare species, mostly present in the Boreal and Alpine domains, where it forms ectomycorrhizae, almost exclusively with spruce (*Picea abies*). It is mainly threatened by silvicultural intensification and soil acidification.

Geography

Global distribution: Europe, Africa (Morocco, Algeria), Asia (Turkey, Russia, China, Japan), North America (USA, Canada, Mexico).

Bibliography: Hesler & Smith (1963), Malençon & Bertault (1975), Bird & Grund (1979), Bessette et al. (1997), Kovalenko (1999), Mao (2000), Garibay-Orijel et al. (2006), Sesli & Denchev (2008).

Distribution in Europe: The species occurs from the lowlands to mountainous regions (in France also above 1200 m).

Besides localities indicated on the map, there are also a few doubtful mentions of the species from the Netherlands (Nauta & Vellinga 1995).



Hygrophorus purpurascens

Photo Yves Denchev



Areal diagnosis for Europe: Mainly Bor. and Alp.; very rare in Arct., Sarm., Atl., C-Eur., Therm. and Medit.; absent from Step.

Trophism, hosts and substrates

The fungus forms ectomycorrhizae almost exclusively with *Picea abies*, very seldom with *Abies alba* (France, Romania) and *Pinus* (Netherlands, France).

Habitat

Vegetation: The species is restricted to spruce forests (e.g. in Finland with grasses and herbs), wooded pastures with spruce and mixed forests with fir; possibly also pine forests.

Syntaxa of vegetation: FORESTS: *Erico carnea-Pinetea sylvestris*, *Fagion sylvaticae* (*Abies* stands) (both France), *Homogyno-Piceetum* (Austria, Germany), *Abieti-Fagetum* (Romania).

Natura 2000 habitats: Wooded dunes of the Atlantic, Continental and Boreal region (code 2180, Netherlands), Western Taiga (code 9010, Finland, Sweden), Fennoscandian herb-rich forests with *Picea abies* (code 9050, Finland), Fennoscandian wooded pastures (code 9070, Sweden), *Asperulo-Fagetum* beech forests (code 9130, France), Acidophilous *Picea* forests of the mountain to alpine levels (*Vaccinio-Piceetea*) (code 9410, Austria, Germany, Romania, Slovakia, Slovenia, Switzerland), Alpine *Larix decidua* and/or *Pinus cembra* forests (code 9420, Switzerland), Subalpine and mountain *Pinus uncinata* forests (code 9430, France).

Soil requirements: The species prefers mesotrophic damp soils and avoids strongly nutrient-poor and strongly acid soils. Soil types: brown soil, basic soils, marl (Germany) and podzol (Finland).

Synanthropy: The species mainly occurs in natural and near-natural habitats (forests), occasionally in semi-natural habitats (pastures).

Indicator value: The fungus is a rather good indicator for spruce forests on soils which are neither too poor in nutrients nor too acid.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced in autumn (August-September).

Frequency

Number of currently known sites: About 40, of which more than 20 are located in Norway and Sweden.

Changes in frequency: The species can be considered as extinct in the Netherlands (not observed after 1988) and in Czech Republic (last record in 1966). A decrease has been noticed in Sweden. In Finland an increase in the number of sites is reported.

Threats and conservation

Threats: Sites are mainly threatened by silvicultural intensification (e.g. clear-cutting, planting of allochthonous trees; see also Kropp & Albee 1996), but also by strong acidification due to air pollution.

Status of conservation: The species is red listed in Czech Republic, Finland, France, Germany, Netherlands, Norway, Sweden and Switzerland. See also Dahlberg & Croneborg (2003, 2006).

Phylloporus pelletieri (Lév.) Quél.

Basidiomycota, Boletales, Boletaceae

Synonyms: *Xerocomus pelletieri* (Lév.) Manfr. Binder, *Phylloporus rhodoxanthus* subsp. *europaeus* Singer [= *Ph. rhodoxanthus* ss. auct. eur.], *Phylloporus paradoxus* (Kalchbr.) Cleland.

Note 1: The combination in the genus *Xerocomus* has been made by Binder (1999), in his thesis.

Note 2: In America occurs *Phylloporus rhodoxanthus* (Schwein.: Fr.) Bres. subsp. *rhodoxanthus* (= subsp. *americanus* Singer 1945b), in Africa subsp. *congolensis* Heinem. (Heinemann & Rammeloo 1987) and in Japan *Phylloporus bellus* (Masse) Corner. Molecular studies support the consideration of the American *Ph. rhodoxanthus* and the European *Ph. pelletieri* as two distinct species (Neves et al. 2012).

Brief description

This medium sized agaricoid species is particular because it belongs to the boletes. It has a reddish brown cap and thick, golden yellow gills which are transversely anastomosed. It is mostly present in the Central-European, Alpine and Atlantic domains. It forms ectomycorrhizae with various tree species, especially beech (*Fagus sylvatica*), oaks (*Quercus* spp.) and chestnut (*Castanea*), on slightly acid soils.

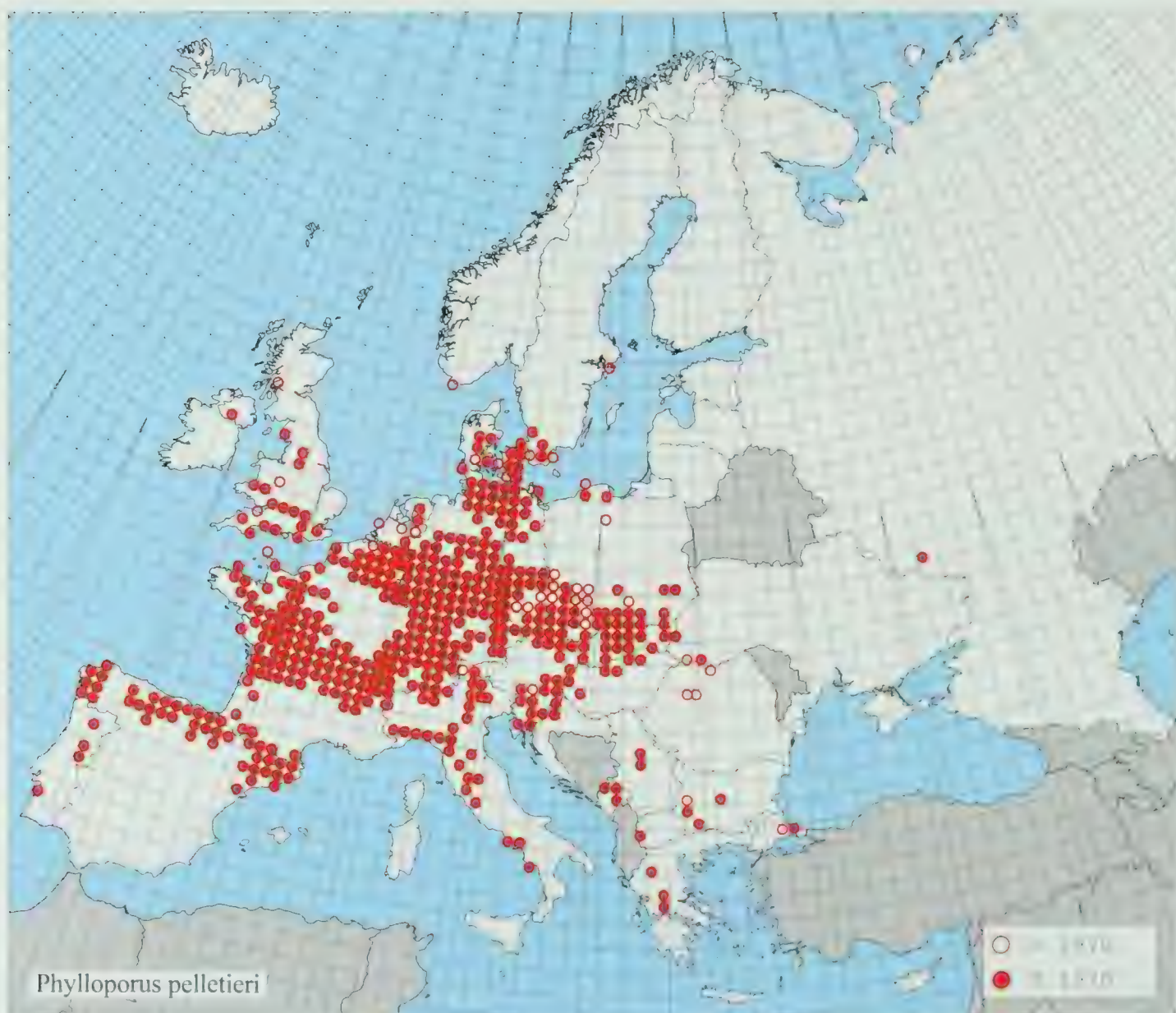
Geography

Global distribution: Europe, Asia (Turkey, Russian Far East, India, China, North Korea,



Phylloporus pelletieri

Photo Jean-Pierre Legros



Japan), Africa (Guinea). Of the 70 species known in the genus *Phylloporus*, *P. pelletieri* is the only one to grow in Europe (Neves 2007).

Bibliography: Skirgiello (1972b), Lange (1974), Teng (1996), Gyosheva (2000), Mao (2000), Ladurner & Simonini (2003), Wojewoda (2003), Wojewoda et al. (2004), Fraiture & Walley (2005), Romkier (2005a), Siller et al. (2005), Bresinsky & Dörfelt (2008), Karadelev & Rusevska (2008), Sesli & Denechev (2008), Diédhiou et al. (2010), Vishwakarma et al. (2012).

Distribution in Europe: The species mainly occurs in lowland to low mountain regions, seldom in higher mountains (e.g. Italy, Montenegro, Ukraine; in Bulgaria up to 1600 m).

The area fits well with the distribution of *Fagus sylvatica*, except for the eastern part of the area; see the maps on p. 22.

Areal diagnosis for Europe: Mainly Atl., C-Eur. and Alp.; also Therm. and Medit.; very rare in Sarm. (south); absent from Arct., Bor. and Step.

Trophism, hosts and substrates

The species forms ectomycorrhizae with deciduous trees, often *Fagus sylvatica* (and *F. xtaurica* = *F. moesiaca* in Montenegro), but also *Castanea sativa* (Hungary, UK), *Quercus cerris* (Hungary), *petraea*, *robur*, *rubra* (Germany), *Carpinus betulus* (Kreisel 1987,

Gyosheva 2000) and probably also *Tilia cordata* (Germany) and (according to Legon & Henrici 2005) also *Alnus*, *Betula* and *Corylus*. The species can also grow in symbiosis with coniferous trees (*Abies alba*, *Picea abies*, *Pinus sylvestris*).

Habitat

Vegetation: Because of its symbiotic lifestyle, the fungus is restricted to wooded biotopes. Most often it occurs in deciduous forests, e.g. alluvial forests, but also in mixed and coniferous forests and plantations, only seldom in nutrient-poor lichen-rich pine forests (e.g. Montenegro) and wooded dunes (Germany). The species preferentially fruits at forest edges and forest banks. It has been rarely found in synanthropic habitats, e.g. roadsides (Netherlands), parks and cemeteries (Germany).

Syntaxa of vegetation: FORESTS: *Ilici-Fagenion*, *Carici-Fagetum*, *Abieti-Fagetum*, *Luzulo-Abietetum*, *Carpinion betuli*, *Genisto tinctoriae-Quercenion robori-petraeae*, *Holco mollis-Quercetum*, *Dicrano-Pinion*, *Leucobryo-Pinetum*, *Pruno-Fraxinetum* (all Germany), *Galio odorati-Fagetum*, *Dentario enneaphylli-Fagetum*, *Dentario glandulosae Fagenion* (all Germany and Poland), *Fagion sylvaticae* (Germany, Poland), *Luzulo-Fagion*, *Vaccinio-Piceetea*, *Pinetalia sylvestris*, *Quercetalia roboris*: *Arbuto-Quercetum petraeae*, *Periclymeno-Quercetum petraeae*, *Sorbo torminalis-Quercetum petraeae*, *Mespilo-Quercetum petraeae*, *Hyperico montani-Quercenion robori-petraeae*, (all France), *Luzulo-Fagetum* (Germany, Hungary), *Melittio-Fagetum subcarpaticum*, *Luzulo-Quercetum*, *Quercus petraeae-Carpinetum pannonicum* (all Hungary), *Carpino-Fagetum* (Romania), *Fagetum moesiaca montanum*, *Piceetum excelsae croaticum* (both Montenegro).

Natura 2000 habitats: Western Taïga (code 9010, Sweden), Fennoscandian hemiboreal natural old broad-leaved deciduous forests (*Quercus*, *Tilia*, *Acer*, *Fraxinus* or *Ulmus*) rich in epiphytes (code 9020, Sweden), *Luzulo-Fagetum* beech forests (code 9110, Czech Republic, France, Germany, Netherlands, Poland, Slovakia, Slovenia, Switzerland), Atlantic acidophilous beech forests with *Ilex* and sometimes also *Taxus* in the shrublayer (code 9120, France, Netherlands), *Asperulo-Fagetum* beech forests (code 9130, Austria, Bulgaria, Denmark, Germany, Luxembourg, Poland, Slovakia, Sweden, Switzerland), Medio-European limestone beech forests of the *Cephalanthero-Fagion* (code 9150, Denmark, Germany, Slovakia), Sub-Atlantic and Medio-European oak or oak-hornbeam forests of the *Carpinion betuli* (code 9160, France, Germany, Netherlands, Poland, Romania, Sweden, Switzerland, UK), *Galio-Carpinetum* oak-hornbeam forests (code 9170, Bulgaria, Czech Republic, Germany, Poland, Slovakia), Old acidophilous oak woods with *Quercus robur* on sandy plains (code 9190, Czech Republic, Germany, Slovakia), *Castanea sativa* woods (code 9260, Croatia), (Sub-)Mediterranean pine forests with endemic black pines (code 9530, Austria), Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*) (code 91E0, Germany, Slovakia), Pannonic woods with *Quercus petraea* and *Carpinus betulus* (code 91G0, Croatia, Slovakia), Pannonian woods with *Quercus pubescens* (code 91H0, Slovakia), Euro-Siberian steppic woods with *Quercus* spp. (91I0, Slovakia), Pannonian-Balkan turkey oak- sessile oak forests (code 91M0, Slovakia).

Soil requirements: The fungus is moderately acidophilous (seldom found on superficially acidified calcareous soils). Soil types: e.g. brown soil, nutrient-rich sandy soil, ranker (Montenegro). Geologic substrate: e.g. limestone, sandstone, granite and porphyry. The species avoids distinctly eutrophic as well as wet sites. Grain size: from sand to clay. Litter layer: absent or thin.

Synanthropy: The fungus grows only seldom in distinctly synanthropic wooded habitats.

Indicator value: The fungus is an indicator of healthy forests, on more or less acid soils not too rich in nutrients.

Occurrence of fruitbodies (phenology)

Basidiocarps are mainly produced from summer till autumn (July-November); in eu-oceanic regions (e.g. UK) still in December.

Frequency

Number of currently known sites: About 1000.

Changes in frequency: In Poland and Sweden, a decrease is reported for the last decades. In Austria, Czech Republic, Denmark, France, Slovakia and Spain no changes have been noticed. In the Netherlands and UK an increase in the number of sites is reported during the last 2 decades.

Threats and conservation

Threats: Sites are mainly threatened by silvicultural intensification (e.g. clear felling and fertilization).

Status of conservation: The species is red listed in Austria, Belgium (regional red list), Bulgaria, Denmark, France, Germany, Hungary, Iberian Peninsula (Spain + Portugal), Moldavia, Montenegro, Norway, Netherlands, Poland, Serbia, Slovakia, Sweden and Switzerland. It is protected by law in Croatia, Hungary, Serbia and Slovenia. See also Dahlberg & Croneborg (2003, 2006).

Boletus dupainii Boud.

Basidiomycota, Boletales, Boletaceae

Brief description

A very striking bolete, with blood-red cap and pores and a pale yellow flesh becoming blue when broken or bruised. It is only present in the southern half of Europe and lives as an ectomycorrhizal species, almost always in connection with oaks (*Quercus*). The species is mainly threatened by degradation and destruction of sclerophyllous forests and by sylvicultural intensification in general.

Geography

Global distribution: Europe, Asia (Turkey, Israel), North America (USA), Central America (Belize).

Bibliography: Singer (1967), Engel et al. (1983), McConnell & Both (2002), Muñoz (2005), Ortiz-Santana et al. (2007), Karadelev & Rusevska (2008), Sesli & Denchev (2008), Both et al. (2009), Kosakyan et al. (2014).

Distribution in Europe: The species mainly occurs in the lowlands, also at warm places in mountain zones (France, Russia, Serbia, in Italy up to 1450 m).





Boletus dupainii

Photo Narcís Macau

The distribution fits well with the southern half of the distribution of *Quercus petraea* s.l. (see Jalas & Suominen 1976: map 299).

Areal diagnosis for Europe: Mainly Atl. (south), Alp., Therm. and Medit.; very rare in C-Eur. (south); absent from Arct., Bor., Sarm. and Step.

Trophism, hosts and substrates

It is an ectomycorrhizal fungus always living in symbiosis with *Quercus* (*Q. cerris*, *ilex*, *petraea*, *pubescens*, *suber*; also *rotundifolia*?) or (exceptionally) with *Castanea sativa*.

Habitat

Vegetation: The species mainly inhabits distinctly thermophilous, deciduous forests dominated by *Quercus*, which are natural or semi-natural often old-growth forests (e.g. Slovenia, with e.g. *Carpinus* and *Fagus* as associated trees). In Italy, the species also colonizes sclerophyllous forests with *Quercus*. In Hungary the fungus was found once in a chestnut plantation.

Syntaxa of vegetation: Forests: *Quercetalia pubescenti-sessiliflorae*, *Quercetalia ilicis*, *Carpinion: Rubio-Fagetum*, *Aceri monspessulani-Fagetum*, *Rusco-Quercetum petraeae*, *Viburno lantanae-Quercetum petraeae* (all France), *Cephalanthero-Fagion* (France, Germany, Slovenia), *Quercetum petraeae-cerris* (Hungary)

Natura 2000 habitats: Medio-European limestone beech forests of the *Cephalanthero-Fagion* (code 9150, France, Germany, Slovakia, Slovenia), Sub-Atlantic and Medio-European oak or oak-hornbeam forests of the

Carpinion betuli (code 9160, Switzerland), *Galio-Carpinetum* oak-hornbeam forests (code 9170, Austria, Slovakia), Pannonic woods with *Quercus petraea* and *Carpinus betulus* (code 91G0, Croatia, Slovakia), Pannonian woods with *Quercus pubescens* (code 91H0, Croatia, Slovakia), Pannonian-Balkan turkey oak - sessile oak forests (code 91M0, Croatia, Hungary, Serbia, Slovakia), Eastern white oak woods (code 91AA, Bulgaria, Macedonia), *Quercus suber* forests (code 9330, Italy), *Quercus ilex* and *Quercus rotundifolia* forests (code 9340, France, Italy).

Soil requirements: The species prefers basic soils (e.g. limestone, dolostone and dolomitic limestone fragments, clay, brown soil), but has also been recorded from acid and neutral soils. It mainly colonizes dry to fresh soils at warm (sunny) places (from Slovenia it is also reported on wet soils), the nutrient content is low to moderate, the litter layer must be absent or thin.

Synanthropy: The species avoids habitats strongly influenced by man.

Indicator value: It is a thermophilous species, typical of the Mediterranean and Sub-Mediterranean *Quercus* stands.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from summer to late autumn (July-November), in Croatia and Serbia already from May/June onwards to autumn.

Frequency

Number of currently known sites: About 100, of which more than 50 in France and Italy.

Changes in frequency: In Austria and Slovenia a decrease is reported for the last 3 decades. In France and Hungary no changes have been noticed.

Threats and conservation

Threats: Sites are mainly threatened by degradation and deforestation of sclerophyllous forests and by intensification of silvicultural practices in general.

Status of conservation: The species is red listed in Austria, Bulgaria, France, Germany, Hungary, Russia (regional red list), Slovakia and Switzerland. It is protected by law in Croatia, Serbia and Slovenia. The species is included in the IUCN *Global Fungal Red List Initiative* (see their web-site). See also Dahlberg & Croneborg (2003, 2006).

Strobilomyces strobilaceus (Scop.: Fr.) Berk.

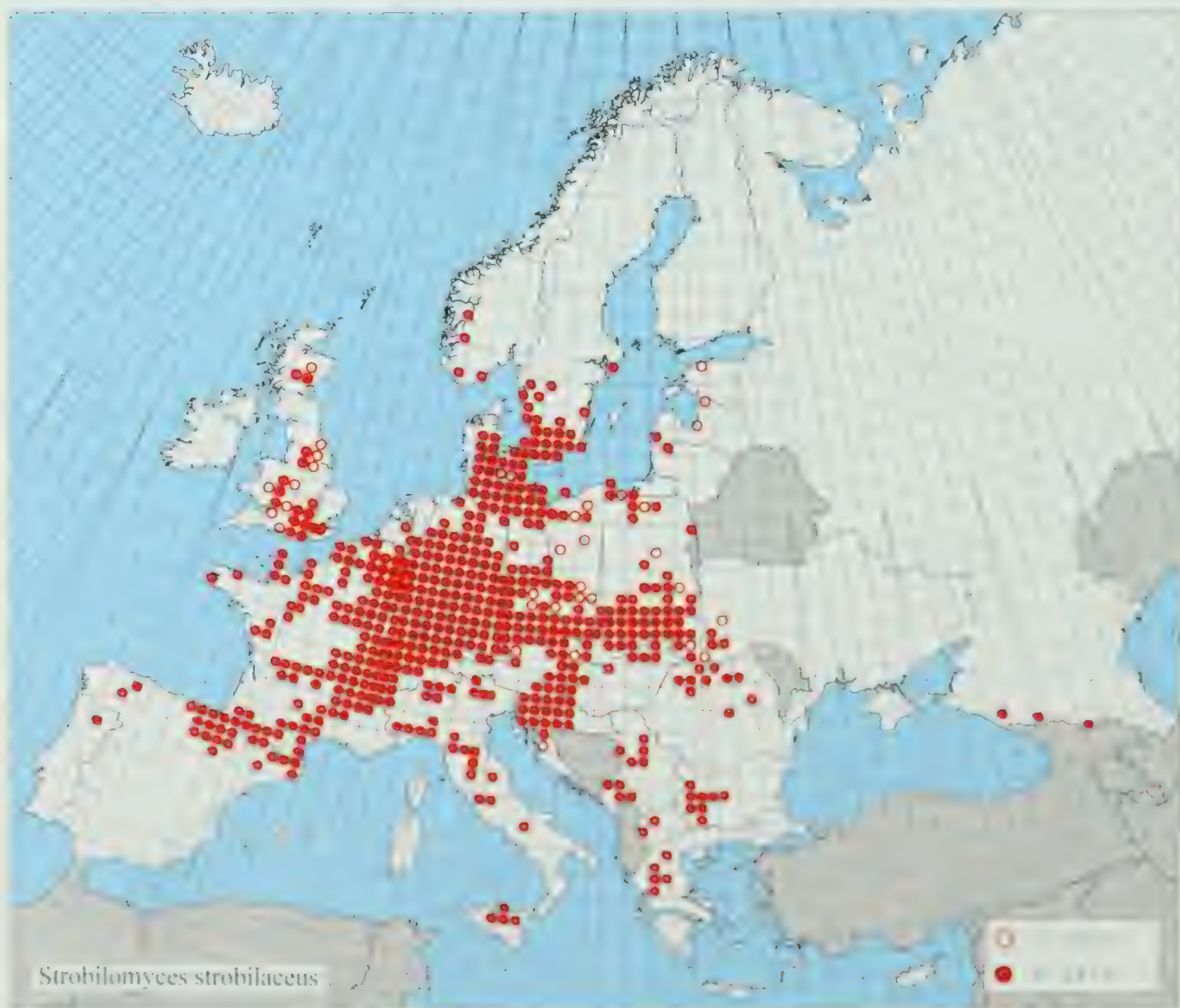
Basidiomycota, Boletales, Boletaceae

Synonym: *Strobilomyces floccopus* (Vahl: Fr.) P. Karst.

Note: After Sato et al. (2007), *S. strobilaceus* could be divided into seven or more species. This could explain the large variability observed in the ecology as well as the diversity of geographical regions occupied by the species in the world. However, recent taxonomic and molecular study showed that only one species exists in Europe and that it should be named *S. strobilaceus*, with *S. floccopus* and *Boletus strobiliformis* Dicks. as synonyms (Petersen et al. 2012).

Brief description

A very distinctive bolete, entirely greyish to blackish, with a ring zone on the stem and a cap appendiculated at the margin and covered with large pyramidal scales. It is relatively rare but largely distributed, mostly in the Central European and Alpine domains and the surrounding regions. It probably forms ectomycorrhizae with various broadleaved trees and with some Pinaceae as well, but some authors have suggested the species was a saprotroph. It is present in a wide range of forest types, on various kind of soils but not too poor nor too acid.



Geography

Global distribution: Europe, Asia (Armenia, Georgia, Kashmir, Russian Far East, India, China, Taiwan, Thailand, North Korea, Japan), Africa (Atlas mountains, South Africa), North America (Canada, USA, Mexico), Central America (Belize, Costa Rica, Cuba), South America (Guatemala), Oceania (Australia).

A doubtful record from Zambia is discussed by Watling & Turnbull (1992).

Bibliography: Singer (1945a), Doidge (1950), Butler & Bisby (1960), Singer (1967, 1970), Smith & Thiers (1971), Skirgielło (1972b), Lange (1974), Grund & Harrison (1976), Singer et al. (1983), Ying & Ma (1985), Watling & Abraham (1992), Both (1993), Teng (1996), Bessette et al. (1997), May & Wood (1997), Mao (2000), Wang & Chou (2001), Wojewoda (2003), Wojewoda et al. (2004), Fraiture & Walley (2005), Muñoz (2005), Siller et al. (2005), Ortiz-Santana et al. (2007), Bresinsky & Dörfelt (2008), Seehanan & Petcharat (2008), Romero-Arenas et al. (2009), Assyov et al. (2011), Alexov et al. (2012), Camino Vilaró (2012), Flores Arzú et al. (2012), Gvritishvili et al. (2012), Vishwakarma et al. (2012).

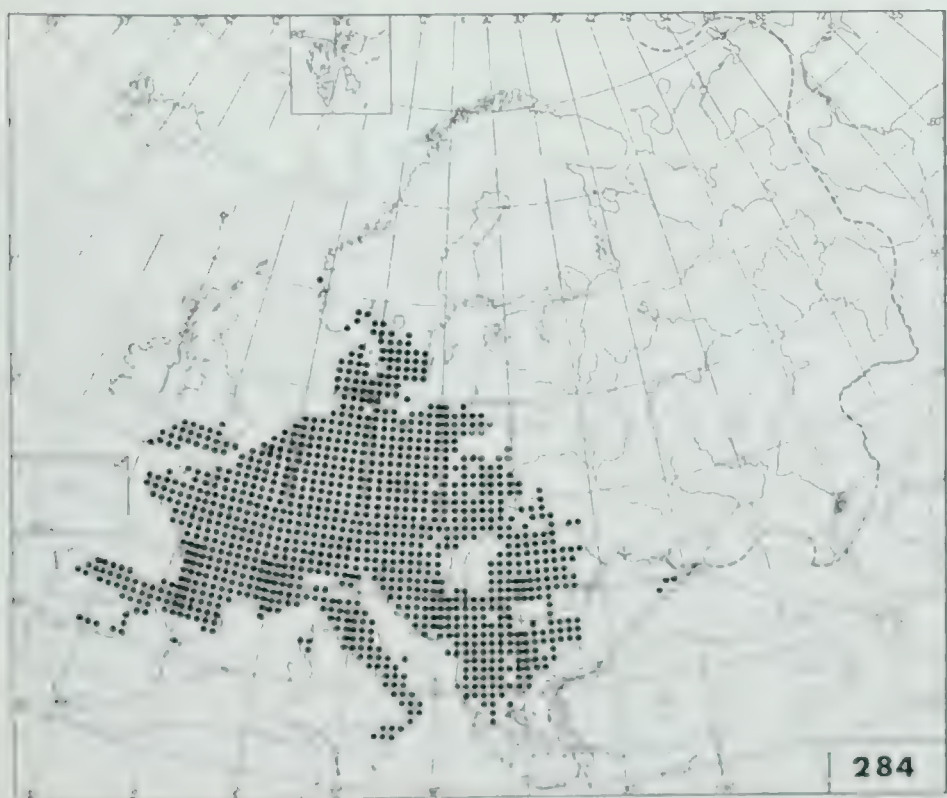
Distribution in Europe: The species occurs from the lowlands to mountainous regions (e.g. in Austria, Bulgaria and Russia above 1200 m).

As already noticed by Skirgielło (1972a), the distribution coincides quite well with that of *Fagus sylvatica* (see the maps below and p. 22). It also fits well with the distribution of *Quercus petraea* s.l. (Jalas & Suominen 1976: map 299).

Areal diagnosis for Europe: Mainly C-Eur.; also Sarm. (west), Atl., Alp., Therm. and Med-it.; very rare in Bor. (one locality in Norway); absent from Arct. and Step.

Trophism, hosts and substrates

The fungus is considered as an ectomycorrhizal species living in symbiosis with deciduous and coniferous trees. However, after Lange (1974), “it is still quite probable that this very peculiar Bolete does not form mycorrhiza at all”. In western and central Europe it prefers *Fagus sylvatica* (subsp. *moesiaca* in Montenegro, *F. orientalis* in Russia), in more southern



Distribution of *Fagus sylvatica* in Europe. From *Atlas Florae Europaeae* 3 (Jalas & Suominen 1976). Courtesy of the Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo.



Strobilomyces strobilaceus

Photo Yves Deneyer

regions there is, outside the mountains, a preference for *Quercus* spp. and *Pinus sylvestris*. The following tree species have also been reported as symbionts: *Betula pendula* (UK), *Carpinus betulus* (e.g. Hungary), *Quercus cerris* (Hungary), *gussonei*, *ilex* (both Italy), *petraea*, *pubescens*, *robur* (e.g. Lithuania), *Tilia cordata* and, among the Pinaceae especially in mountainous regions, *Abies alba*, *Picea abies* and *Larix decidua* (Germany) as well as *Pinus* (Kreisel 1987, Legon & Henrici 2005). The mention of *Fraxinus excelsior* (Oleaceae) as a weak mycotrophic tree seems doubtful (Kreisel 1987). After Sato et al. (2007), *Strobilomyces* species would have only Fagaceae hosts. The fungus is considered as related to the *Clitocybe brumali-Phellodonetum nigri* (Czech Republic).

Habitat

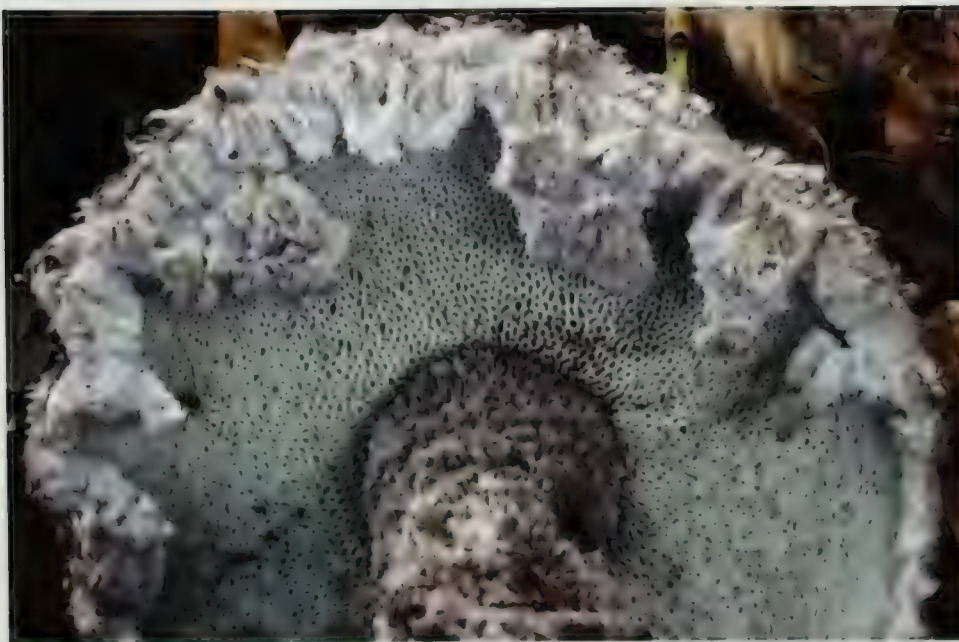
Vegetation: The European *Strobilomyces* is able to grow in a wide range of forest types. It mainly occurs in deciduous forests, most often beech forests, but also occasionally in oak and oak-hornbeam forests. It has also been reported in sclerophyllous oak forests (Italy), in several types of mixed forests (e.g. beech-fir forests in Russia), and in coniferous forests, mainly mountain spruce forests (e.g. Austria, Poland) but also lowland pine forests (e.g. in Germany and Poland moss and lichen-rich). The species also finds suitable conditions in plantations, especially in spruce plantations in central Europe. It is rarely synanthropic, growing in hedges and in parks (Germany, Poland). After Watling (1970), it often grows in deep shade.

Syntaxa of vegetation: Forists: *Fagion sylvaticae*, *Galio odorati-Fagenion*, *Galio odorati-Fagetum*, *Hordelymo-Fagetum*, *Carici-Fagetum*, *Tilio-Acerion*, *Adoxo moschatellinae-Aceretum*, *Carpinion betuli*, *Galio*

sylvatici-Carpinetum, *Stellario holostaeae-Carpinetum betuli*, *Genisto tinctoriae-Quercenion robori-petraeae*, *Genisto tinctoriae-Quercetum petraeae*, *Holco mollis-Quercetum*, *Vaccinio-Abietetum*, *Luzulo-Abietetum*, *Leucobryo-Pinetum* (all Germany), *Luzulo-Fagetum* (Germany, Poland), *Fagetalia*, *Dicrano-Pinion*, *Vaccinio-Abietion*, *Vaccinio-Piceion*, *Abietetum polonicum*, *Dentario glandulosae-Fagetum*, *Pino-Quercetum*, *Tilio-Carpinetum* (all Poland), *Tilio-Quercetum* (Lithuania), *Dentario enneaphylli-Fagetum* (Czech Republic), *Quercion pubescenti-petraeae*, *Quercus petraeae-Carpinetum*, *Quercetum petraeae-cerris*, *Melittio-Fagetum*, *Deschampsio flexuosae-Fagetum* (all Hungary), *Fagion sylvaticae*, *Quercetum mixtum* (both Bulgaria), *Festuco heterophyllae-Fagetum*, *Calamintho grandiflorae-Fagetum* (both Macedonia), *Fagetum moesiacaе montanum* (Montenegro).

Natura 2000 habitats: Fennoscandian hemiboreal natural old broad-leaved deciduous forests rich in epiphytes (*Quercus*, *Tilia*, *Acer*, *Fraxinus* or *Ulmus*) rich in epiphytes (code 9020, Latvia, Norway), *Luzulo-Fagetum* beech forests (code 9110, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Netherlands, Poland, Slovakia), *Asperulo-Fagetum* beech forests (code 9130, Bulgaria, Denmark, Germany, Hungary, Poland, Slovakia, Sweden), Sub-Atlantic and medio-European oak or oak-hornbeam forests of the *Carpinion betuli* (code 9160, Germany, Latvia, Poland, Slovakia, Sweden), *Galio-Carpinetum* oak-hornbeam forests (code 9170, Croatia, Germany, Poland, Slovakia), *Tilio-Acerion* forests of slopes, screes and ravines (code 9180, Norway, Slovakia), Old acidophilous oak woods with *Quercus robur* on sandy plains (code 9190, Slovakia), Moesian silver fir forests (code 91BA, Croatia), Pannonic woods with *Quercus petraea* and *Carpinus betulus* (code 91G0, Hungary, Slovakia), Pannonian woods with *Quercus pubescens* (code 91H0, Slovakia), Euro-siberian steppic woods with *Quercus* spp. (code 91I0, Slovakia), Pannonian-Balkanic turkey oak - sessile oak forests (code 91M0, Hungary, Slovakia), Holy Cross fir forests (*Abietetum polonicum*) (code 91P0, Poland), Moesian beech forests (code 91W0, Greece, Macedonia, Montenegro), Apennine beech forests with *Abies alba* and beech forests with *Abies nebrodensis* (code 9220, Italy), *Quercus ilex* and *Quercus rotundifolia* forests (code 9340, Italy), Acidophilous *Picea* forests of the mountain to alpine levels (*Vaccinio-Piceetea*) (code 9410, Poland).

Soil requirements: The euryoecious species inhabits a wide range of soils. Most often it was found on fresh to damp soils, not too acid nor too poor in nutrients. Soil types: clayey brown soil is most typical, but the species has also been found on ranker, rendzina, regosol, podzol. Geologic substrate: diabas, gypsum (both Germany), limestone, granite (e.g. Bulgaria, Macedonia), sandstone, schist (Germany). In regions with drier climate it prefers comparatively wet soils (e.g. Slovenia, Spain), occasionally it was found on clearly dry and warm soils (e.g. Italy), seldom at more or less oligotrophic sites (e.g. Germany), but never at eutrophic ones. The fungus has mainly been found on a thin litter layer but tolerates also its absence or a thicker one (Denmark, Spain).



Strobilomyces strobilaceus.
Photo Yves Deneyer

Synanthropy: The species occurs in different kinds of wooded areas, mainly in forests but also in plantations and other anthropogenic habitats.

Indicator value: As a rather euryoecious fungus it doesn't have a very good indicator value. It can be regarded as typical for mesophilous deciduous forests.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from early summer till autumn (June-November).

Frequency

Number of currently known sites: More than 1000.

Changes in frequency: In Estonia there is no record after 1961. In Hungary, Latvia, Poland and Slovenia a decrease is reported for the last 2-3 decades, in the Netherlands for the last 5 decades. In Austria, France, Russia, Slovakia and Spain no changes have been noticed. In Romania and UK an increase in the number of sites is reported for the last decades.

Threats and conservation

Threats: Sites are mainly threatened by silvicultural intensification (e.g. clear felling and fertilization of coniferous forests).

Status of conservation: The species is red listed in Belgium (regional red list), Bulgaria, Estonia, France, Hungary, Iberian Peninsula (Spain + Portugal), Latvia, Montenegro, Netherlands, Poland, Serbia, Russia and Ukraine. The fungus is protected by law in Hungary, Poland, Slovenia and Ukraine.

Suillus flavidus (Fr.: Fr.) J. Presl

Basidiomycota, Boletales, Suillaceae

Synonyms: *Boletus flavidus* Fr.: Fr., *Ixocomus flavidus* (Fr.: Fr.) Quél., *Boletus velatus* Pers., *Boletus pulchellus* Fr., ? *Boletus extractus* Britzelm., ? *Suillus umbonatus* Dick & Snell (synonymy after Redeuilh & Simonini 1998).

Note 1: The combination in *Suillus* is often attributed to Singer (1945b), but it has been made one century before, by J. Presl, *Wšeobecny rostlinopis* 2: 1918 (1846).

Note 2: The f. *juranus* Quélet (1895: 620) differs from the type by a pinkish shade and has been found in peatbogs, under *Pinus uncinata*, in France (Jura).

Note 3: In North America, the species is regarded by some authors as conspecific with *Suillus umbonatus* Dick & Snell (see Smith et al. 1965 and Both 1993).

Brief description

A small to medium sized bolete, entirely yellowish, with a viscid cap and a stem provided with a gelatinous ring. It is mostly present in the Boreal, Central-European, Alpine and (westernmost part of) Sarmatic domains. It is an ectomycorrhizal species living in symbiosis with 2-needled pines (mostly *Pinus sylvestris*) in peat bogs, mires and swampy pine woods, on strongly acid to nearly neutral soils. It is mainly threatened by large-scale draining of bogs and mires.



Suillus flavidus

Photo Daniel Ghyselinck

Geography

Global distribution: Europe, Africa (South Africa), Asia (Georgia, Turkey, Ural Mountains, Siberia, China), North America (USA).

Bibliography: Doidge (1950), Skirgiello (1972b), Lange (1974, map), Mao (2000), Ding & Wen (2003), Fraiture & Walley (2005), Muñoz (2005), Stasińska (2011), Doğan et al. (2012), Gvritishvili et al. (2012).

Distribution in Europe: The species occurs from the lowlands to mountainous regions (e.g. in France and Slovenia above 1200 m). According to Lange (1974), it has been found up to 1700 m alt. in Austria.

Besides localities indicated on the map, the species is also present in Belarus (fide Dörfelt & Bresinsky 2003). See also the map proposed by these authors for Germany.

Areal diagnosis for Europe: Mostly abundant in Bor., Sarm., C-Eur. and Alp.; also observed in Arct., Atl. (mostly northern half) and Therm.; very rare in Medit. (Spain); absent from Step.

Trophism, hosts and substrates

The fungus is an ectomycorrhizal species always living in symbiosis with *Pinus*, mainly *P. sylvestris* in the low- and uplands and *P. mugo* s.l. in the mountains (subsp. *rotundata* and *P. uncinata*) and in northern Europe (introduced to Iceland with *Pinus mugo*). In Sweden it has also been recorded under the planted North American *Pinus contorta* and, in Denmark, even under *Picea abies*. Estades & Lannoy (2004) confirm that the species has been (rarely) found under *Picea abies*. Mostly the fungus forms fruitbodies among *Sphagnum* spp.

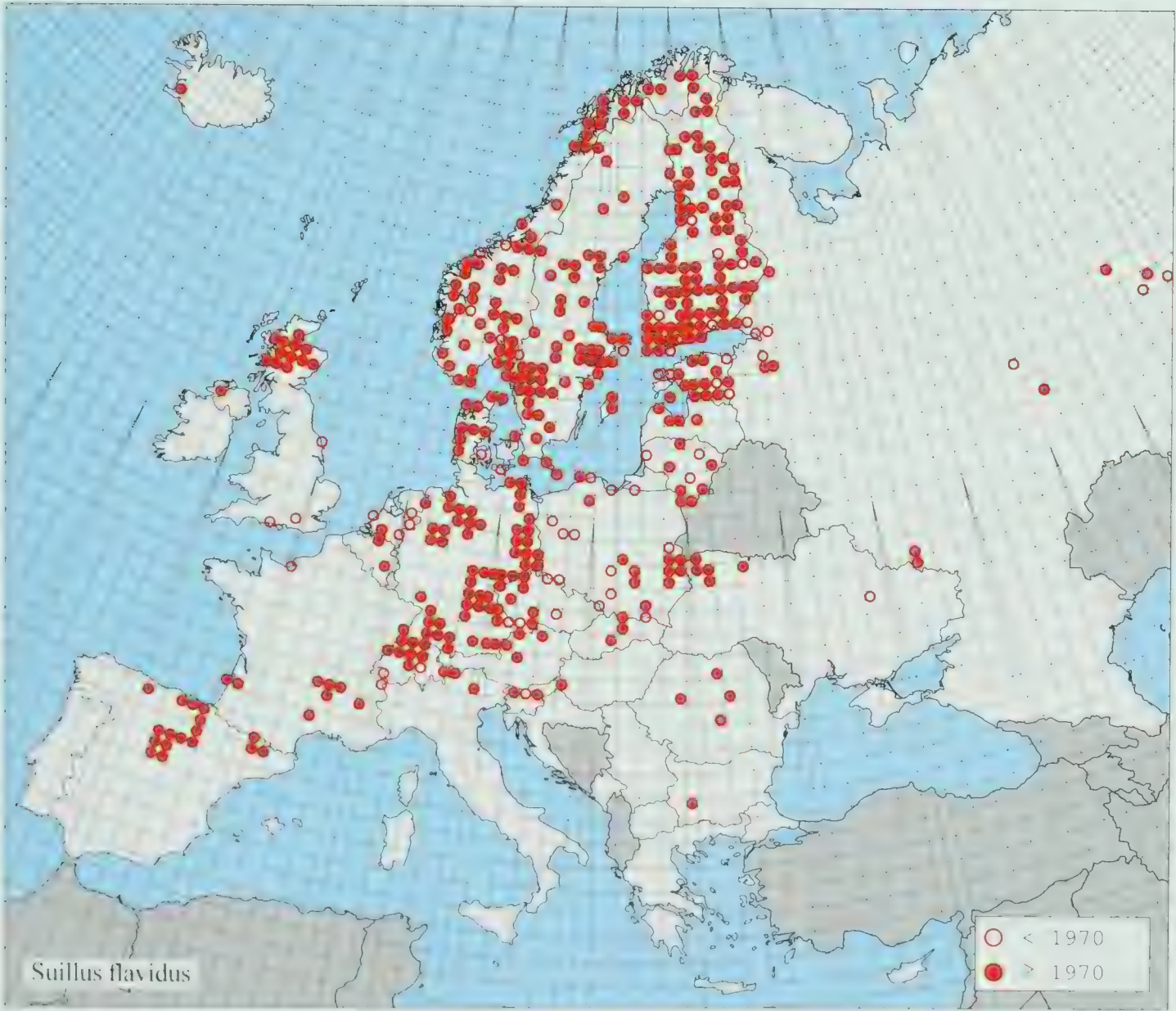
Habitat

Vegetation: The fungus mainly inhabits peat bogs, transitional mires and boggy to swampy pine forests (e.g. with *Erica tetralix* in Poland), occasionally wet to moist pine forests without distinct peat layer (e.g. in dune areas in Germany) and wet oak-pine forests (Ukraine). In Germany and UK the species has also been found in pine plantations, in Czech Republic even at fishpond margins under pine (influenced by man?). See also Singer (1965) and Stasińska (2011).

Syntaxa of vegetation: FORESTS AND WOODED BOGS: *Dicrano-Pinion*, *Pyrolo-Pinetum*, *Vaccinio uliginosi-Pinetum rotundatae*, *Ledo-Pinetum sylvestris*, *Vaccinio uliginosi-Betuletum pubescentis*, *Betuletum carpaticae* (all Germany), *Vaccinio uliginosi-Pinetum sylvestris* (Germany, Poland, Romania, Russia), *Corymphonetum canescentis*, *Empetro nigri-Pinetum* (both Poland), *Pinetum calluneto-vaccinietosum* (Czech Republic), *Eriophoro vaginati-Pinetum sylvestris* (Romania); OPEN BOGS AND WET HEATHS: *Scheuchzerio-Caricetea nigrae* (Germany), *Oxycocco-Sphagnetum* (Germany, Russia), *Ericetum tetralicis*, *Eriophoro-Sphagnetum medii*, *Sphagnetum magellanici*, *Ledo-Sphagnetum magellanii* (all Poland).

Natura 2000 habitats: Wooded dunes of the Atlantic, Continental and Boreal region (code 2180, Denmark, Germany, Poland), Humid dune slacks (code 2190, Latvia), Northern Atlantic wet heaths with *Erica tetralix* (code 4010, Poland), Active raised bogs (code 7110, Austria, Germany, Latvia, Netherlands, Poland, Slovakia), Degraded raised bogs still capable of natural regeneration (code 7120, Latvia, Slovakia), Transition mires and quaking bogs (code 7140, Germany, Slovakia), Western Tunga (code 9010, Norway, Sweden), Caledonian forest (code 91C0, Norway), Bog woodland (code 91D0, Czech Republic, Estonia, Netherlands, Poland, Sweden), Mediterranean pine forests with endemic Mesogean pines (code 9540, Macedonia).

Soil requirements: It is a clearly hygrophilic species, often found on strongly acid to nearly neutral oligotrophic to mesotrophic peat (histosols), sometimes also on wet to moist nutri-



Distribution of *Pinus sylvestris* in Europe. From *Atlas Florae Europaeae* 2 (Jalas & Suominen 1973). Courtesy of the Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo.

ent-poor acid podzols. From Romania also reported on acid brown soils and in Iceland on andosol. Geologic substrate: granite and volcanic rocks (Romania).

Synanthropy: The species should be regarded as anthropophobic. Only exceptionally it was found in biotopes moderately influenced by man.

Indicator value: The species is typical for natural and near-natural wet wooded habitats (bogs, mires, swampy and boggy forests).

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from summer to autumn (July-October); in Spain still in November.

Frequency

Number of currently known sites: About 500.

Changes in frequency: In France, Germany and Netherlands a decrease is reported for at least the last 5 decades. In Estonia, Finland, Lithuania, Poland, Slovakia and Spain no changes have been noticed. In UK an increase in the number of sites is reported.

Threats and conservation

Threats: In the past the number of sites decreased, mainly due to large-scale draining of bogs and mires.

Status of conservation: The species is red listed in Austria, Belgium (regional red list), Czech Republic, Denmark, France, Germany, Iberian Peninsula (Spain + Portugal), Netherlands, Poland, Slovakia and Switzerland. It is protected by law in Czech Republic, Slovakia and Slovenia. It is included in the IUCN *Global Fungal Red List Initiative* (see their web-site).

Suillus sibiricus (Singer) Singer

Basidiomycota, Boletales, Suillaceae

Synonym: *Ixocomus sibiricus* Singer.

Note: The subsp. *helveticus* Singer has never been validly described (Redeuilh & Simonini 1998: 77). It only differs from the type variety by very small details (Singer 1965: 70). It is limited to the European continent, where it is the only subspecies of *S. sibiricus*.

Brief description

A medium sized bolete, entirely yellowish, with a viscid and appendiculate cap which is dotted with brown, and a stem provided with a woolly ring. It is almost exclusively present in the Alpine domain. It grows as an ectomycorrhizal species, in symbiosis with 5-needled pines (*Pinus cembra* and *P. peuce*), in forests and scrubs or in extensively used pastures with scattered trees, mostly on acid soils relatively poor in nitrogen. It is mainly threatened by logging of subalpine forests.

Geography

Global distribution: Europe (subsp. *helveticus*), North America (USA), Asia (subsp. *sibiricus*: Siberia, China, Kashmir, Pakistan).

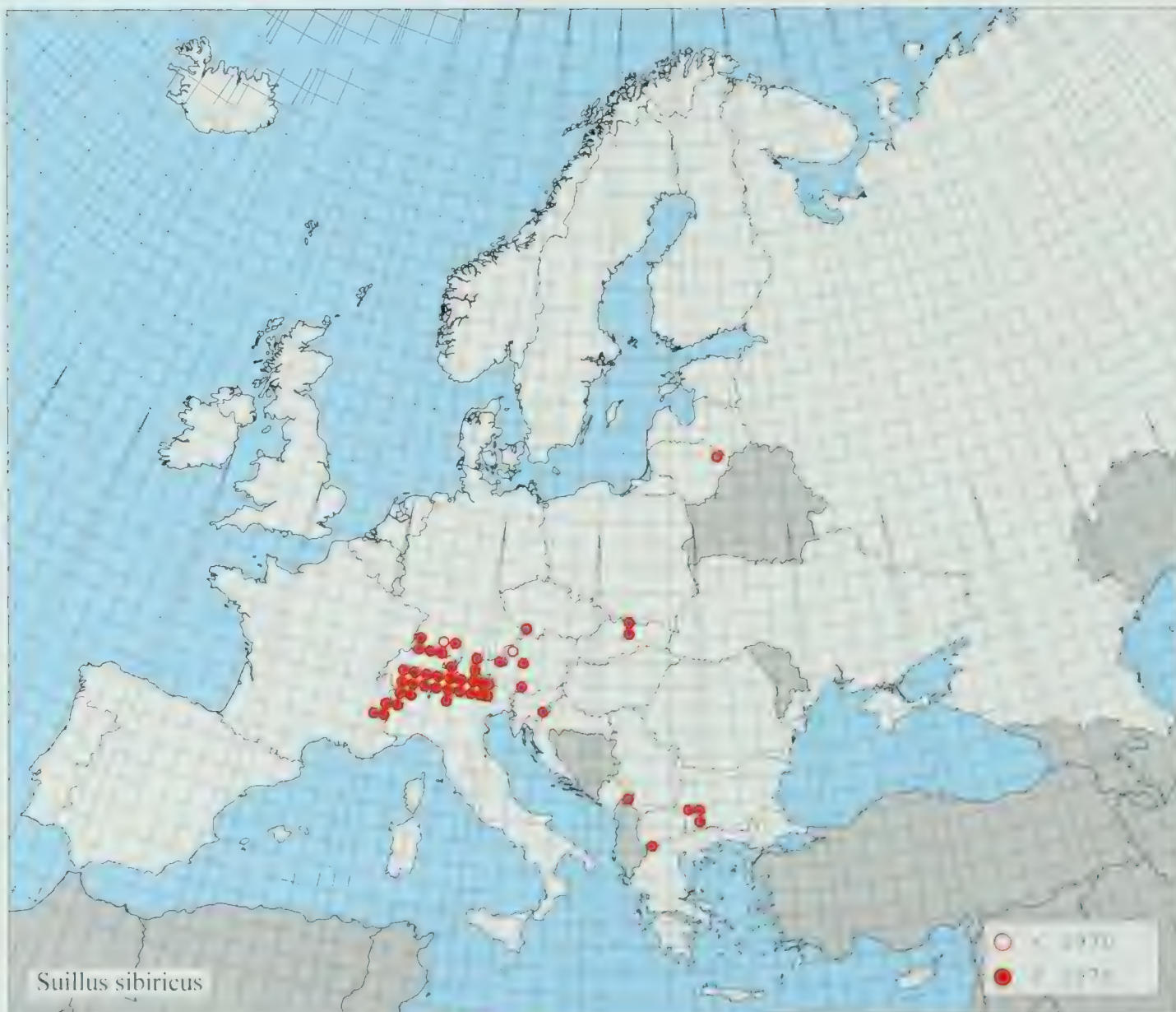
The species has also been mentioned as introduced in Africa (Tanzania, Zambia) but it is probably a misidentification (Heinemann & Rammeloo 1989).

Bibliography: Smith & Thiers (1964), Smith et al. (1965), Kluzák & Papoušek (1989), Watling & Abraham



Suillus sibiricus

Photo Yves Deneyer



(1992), Both (1993), Mao (2000), Ding & Wen (2003), Muñoz (2005), Karadelev & Rusevska (2008), Sarwar et al. (2011).

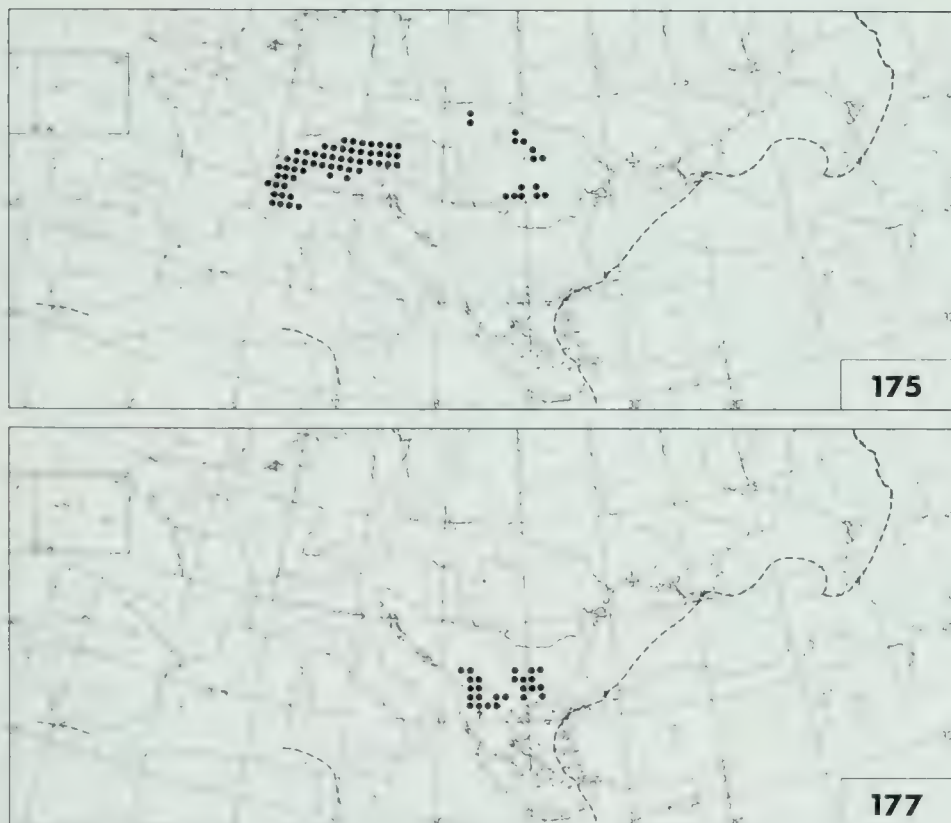
Distribution in Europe: The species only occurs in higher mountains (subalpine zone above 1200 m) (Torti  1967, Ronikier 2005f). See also on p. 25.

There is some uncertainty about the Polish mentions (Ronikier 2005f). Besides localities indicated on the map presented here, the species is also present in Albania (Karadelev et al. 2013). The mentions in Czech Republic (C-Eur.) and Lithuania (Sarm.) are synanthropic. The species follows the distribution of its hosts, *Pinus cembra* (except in Romania) and *P. peuce*. Both species of trees are endemic to Europe.

Areal diagnosis for Europe: Almost exclusively Alp.; very rare in Sarm. (one report in Lithuania), C-Eur. (south) and Thermomem; absent from Arct., Bor., Atl., Medit. and Step.

Trophism, hosts and substrates

The species forms ectomycorrhizae with *Pinus cembra* in the Alps and the Tatra mountains (Singer 1965, Prihoda 1971, Estades & Lannoy 2004, Riva 2006) and with *Pinus peuce* in the mountains of the Balkan Peninsula (Torti  1967, D rfelt & M sch 1987, Assyov 2004). A symbiosis with *Pinus sylvestris* could also be possible (Germany).



Distribution of *Pinus cembra* (above) and *P. peuce* (below) in Europe. From *Atlas Florae Europaeae* 2 (Jalas & Suominen 1973). Courtesy of the Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo.

Habitat

Vegetation: The fungus mainly occurs in subalpine stands of *Pinus cembra*, either in forests and scrubs (dwarf pine zone), or in extensively used pastures with scattered trees. In Poland it grows among *Vaccinium myrtillus*. Twice the species was found synanthropic, in Lithuania under *Pinus cembra* and in Czech Republic, in a park under *Pinus peuce*.

Syntaxa of vegetation: FORESTS: *Vaccinio-Pinetum cembrae*, *Dicrano-Pinion* (Germany), *Pinion peucis* (Bulgaria), *Digitali viridiflorae-Pinetum peuces* (Macedonia); SHRUBS: *Pinetum mugo carpaticum* (Poland), *Rhododendro-Vaccinion*, *Juniperion nanae*, *Rhododendro hirsuti-Pinion mugo* (all France).

Natura 2000 habitats: Alpine *Larix decidua* and/or *Pinus cembra* forests (code 9420, Austria, France, Germany, Italy, Poland, Slovakia, Switzerland), High oro-Mediterranean pine forests (code 95A0, Bulgaria, Macedonia).

Soil requirements: The species mainly inhabits acid soils, but occasionally also neutral and basic ones (Bulgaria, France and Switzerland). Soil types: brown soil (Bulgaria), podzol (Macedonia) and ranker (e.g. Poland). Geologic substrate: granite (e.g. Macedonia, Slovakia), marble and schist (both Bulgaria). Nitrogen content: low or moderate (in Macedonia also high?). Grain size: from sand to clay. Litter layer: thin to thick.

Synanthropy: The fungus is mainly restricted to natural (forests) and near-natural habitats (extensively used wooded pastures). It was rarely found in anthropogenic habitats.

Indicator value: The species is characteristic of the subalpine sites with *Pinus cembra* or *Pinus peuce*.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from summer to autumn (July-October).

Frequency

Number of currently known sites: About 60.

Changes in frequency: In France and Macedonia no changes have been noticed.

Threats and conservation

Threats: Sites are mainly threatened by logging of subalpine forests (e.g. to build facilities for winter sport).

Status of conservation: The species is red listed in Austria, Bulgaria, Czech Republic, France, Germany, Macedonia, Poland, Slovakia and Switzerland. It is protected by law in Slovakia. About 70 percent of the currently known sites are located in Switzerland. The species is included in the IUCN *Global Fungal Red List Initiative* (see their web-site). See also Dahlberg & Croneborg (2003, 2006).

Pisolithus arrhizus (Scop.: Pers.) Migula s.l.
Basidiomycota, Boletales, Sclerodermataceae

Synonyms: *Pisolithus tinctorius* (Pers.: Pers.) Coker & Couch, *P. arenarius* Alb. & Schwein.

Note: There is some uncertainty about the spelling of the epithet “*arrhizus*”. Scopoli (1786, *Del. Fl. Faun. Insubr.* 1: 40) described *Lycoperdon arrizon*. Fifteen years later, Persoon (1801: 152, *Syn. Meth. Fung.*) cited the basionym as “*Lycoperdon arhizon*” and combined the name into *Scleroderma arhizum*. Migula, *Krypt. Fl.* III 2 (2): 765 (1912) published the combination *Pisolithus arrhizus*. Later on, Rauschert (1959) published the superfluous combination *Pisolithus arhizus*. According to the rules of transliteration from Greek to Latin, the best spelling should be “*arrhizus*”. It is also the spelling recommended by Stearn (1992) and it is widely used, (but “*arhizus*” as well).

Brief description

A striking gasteromycete forming sporophores composed of a pseudostipe carrying a subglobose head whose flesh is brown and pulverulent when ripe and contains numerous yellow pseudoperidioles. It is mainly present in Central European, Mediterranean and Atlantic domains. It is an ectomycorrhizal species, living in symbiosis with numerous coniferous and broadleaved tree species, on acid soils in a wide range of habitats, including substrates devoid of organic matter (e.g. slag heaps of coal mining, where it is associated with *Betula*).

Geography

Global distribution: Europe, Asia (Georgia, Turkey, Israel, India, Thailand, China, Japan, Indonesia, Malaysia), Africa (Canary Islands, Cape Verde Islands, Atlas Mountains, Sene-

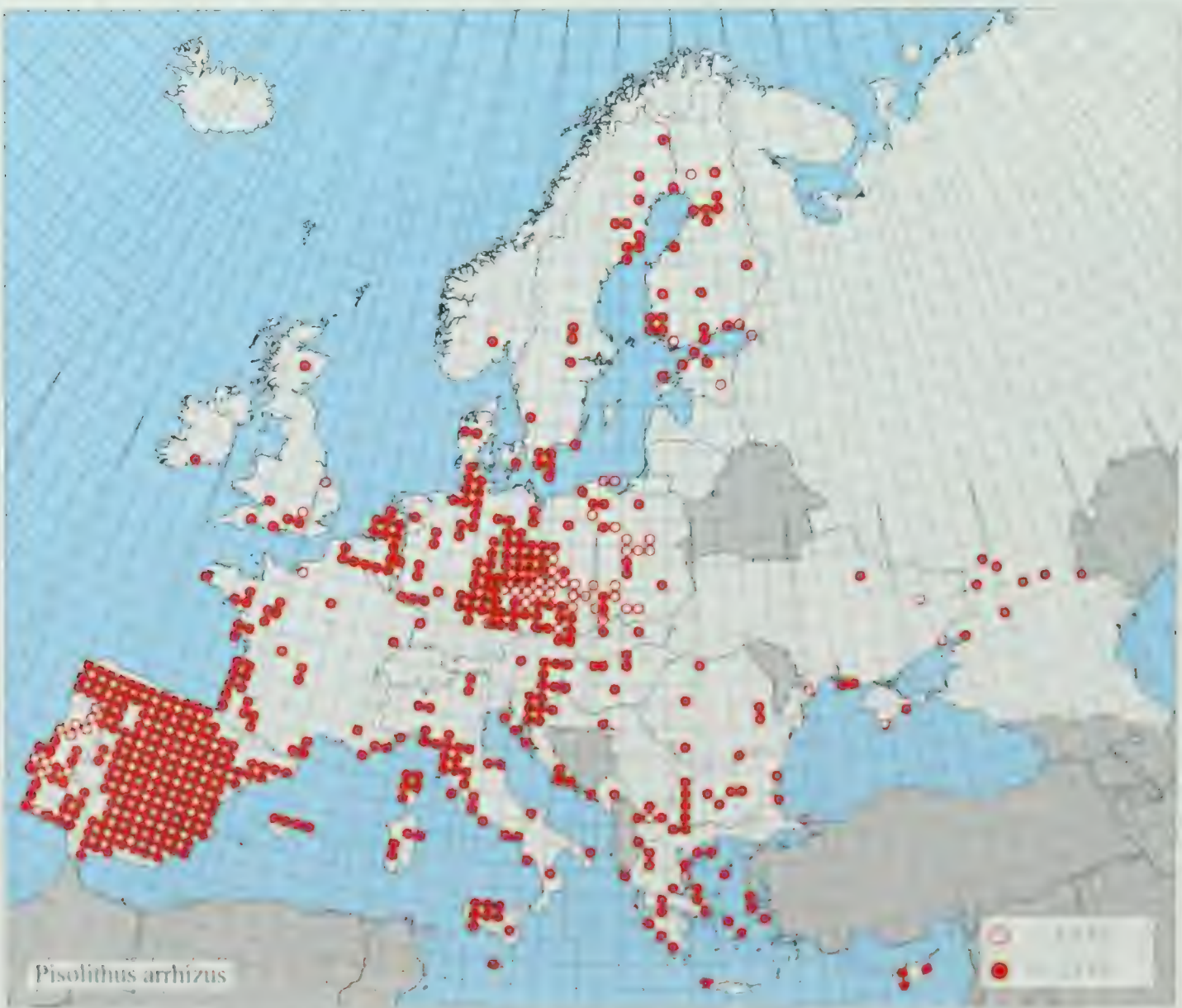


Pisolithus arrhizus Photo Daniel Ghyselinck

gal, Burkina Faso, Congo, Rwanda, Kenya, Zambia, Zimbabwe, South Africa, Mauritius), North America (USA, Mexico), Central America (Nicaragua, Costa Rica, Philippines, Cuba), South America (Guatemala, Venezuela, Brazil), Oceania (Australia, Tasmania, New Zealand, New Caledonia).

Bibliography: Cunningham (1942), Doidge (1950), Smith (1951), Dissing (1963), Dring & Rayss (1963), Dissing & Lange (1964), Lange (1974), Demoulin & Dring (1975), Grand (1976), Beltrán Tejera & Wildpret de la Torre (1977), Gross et al. (1980), Liu (1984), Ing (1985), Urista et al. (1985), Eckblad & Brochmann (1988), Calonge et al. (1988, 1992a, 1992b), Calonge & Almeida (1992), Fan et al. (1994), Pegler et al. (1995), Moyersoén & Demoulin (1996), Teng (1996), Bessette et al. (1997), Beltrán Tejera et al. (1998), Mao (2000), May et al. (2003), Calonge et al. (2005), Fraiture & Walley (2005), Sarasini (2005), Bresinsky & Dörfler (2008), Sesli & Denchev (2008), Hosaka (2009), Costa Maia & Alves de Carvalho (2010), Moreno et al. (2010), Camino Vilaró (2012), Flores Arzú et al. (2012), Gvritishvili et al. (2012), Iturriaga & Minter (2012), Minter & da Silva (2012), Sharp (2014).

Note: The above distribution concerns *Pisolithus arrhizus* s.l. The fungus has been traditionally considered as a cosmopolitan species, growing with a large variety of hosts (Marx 1977). However, recent studies have shown it was constituted by a complex of at least 11 species (Martin et al. 2002, Kanchanaprayudh et al. 2003, Kasuya et al. 2008, Hosaka 2009). *P. arrhizus* s.str. grows in association with *Pinus* and *Quercus* species in the northern



hemisphere and has been introduced in various places of the southern hemisphere. It is the taxon which is usually found in Europe but other species are present on the continent as well. Two undescribed species have been found in Spain (Díez et al. 2001), one on *Cistus* and the other one on *Pinus* and *Quercus*. On the other hand, two species native of Australia, *P. microcarpus* and *P. albus*, have been introduced in *Eucalyptus* plantations, in Portugal and Spain.

Distribution in Europe: The species mainly occurs from lowlands to lower mountainous regions: e.g. in Germany up to 700 m, only in Italy also above 1200 m (Rudnicka-Jezierska 1991, Moyersoen & Demoulin 1996, Calonge 1998, Sarasini 2005).

Besides localities indicated on the map presented here, the species is also present in Albania (Karadelev et al. 2013).

Areal diagnosis for Europe: Mainly C-Eur. and Medit.; also Bor., Sarm. (west) and Atl.; rare in Alp., Therm. and Step.; absent from Arct.

Trophism, hosts and substrates

It is an ectomycorrhizal fungus, living in symbiosis with coniferous trees, *Cupressus sempervirens* (Italy), *Picea abies* (e.g. Romania, Slovenia), or *Pinus* (*P. halepensis* in Greece and Italy, *pinaster* in Greece, *nigra*, *pinaster* in Portugal, *pinea*, *sylvestris*), with deciduous and sclerophyllous trees, *Betula pendula* (e.g. Hungary, Belgium, Germany), *Salix caprea* (Belgium), *Populus* (Germany), *Quercus* (*Q. cerris* in Hungary, *ilex*, *petraea*, *pubescens*, *robur* in Russia, *rubra* in Germany, *suber*). There are debatable records of a symbiosis with *Erica arborea* and *Olea europea* (both Italy) and *Rhamnus* (Germany). Findings in *Eucalyptus* plantations (*E. camaldulensis* and *E. sp.*) in Italy, Malta and Portugal probably belong to *Pisolithus albus* (Cooke & Masee) Priest, *P. microcarpus* (Cooke & Masee) G. Cunn. or *P. marmoratus* (Berk.) E. Fisch. Observations connected with *Cistus* (*C. creticus*, *salvifolius* both in Italy, *monspeliensis* in Greece, *ladanifer* in Portugal, fide Torrejón 2008), in the Mediterranean domain, probably also concern other species than *P. arrhizus* s.str. (see the note above).

Habitat

Vegetation: The species inhabits a wide range of coniferous (e.g. pine forests of the *Cladonia* and *Vaccinium vitis-idaea* types in Estonia), mixed, deciduous and sclerophyllous forests (e.g. *Quercus ilex* and *Q. suber* forests in Italy). It also regularly occurs in plantations, most often with pine (e.g. oak-pine plantations in forest-steppes and steppes in Ukraine). The fact that the soil of many growthplaces is devoid of any herbaceous plant (but not of mosses and lichens) is an indication that they are dry and nutrient-poor. Mainly in temperate western and central Europe, the species is rather common in birch pine pioneer forests on renaturalised brown coal mining, sand pits and different other mining areas, as well as in woodland developed on mining waste and slag disposal areas. In this part of Europe the fungus does not grow in undisturbed forests with old trees. It is able to colonize also grey coastal dunes, inland dunes and heaths with pine (e.g. Poland), furthermore macechia, dry grasslands and dry rocky areas, always in association with trees. Occasionally, the species was found in strong anthropogenic biotopes such as ruderal places (Hungary), roadsides (e.g. Italy, UK), gardens (Germany) and parks (e.g. Poland, Slovenia). See also Lange

Pisolithus arrhizus.
Photo Joseph Pellicani



(1974), Moyersoen & Demoulin (1996), Chambers & Cairney (1999), Sarasini (2005) and Bresinsky & Dörfelt (2008).

Syntaxa of vegetation: FORESTS: *Leucobryo-Pinetum* (Germany, Poland), *Quercetum petraeae-cerris* (Hungary), *Soldanello majori-Piceetum* (Romania), *Quercetum frainetto-cerris*, *Quercus-Carpinetum orientalis* (Bulgaria, Macedonia), *Rusco-Carpinetum orientalis* (Montenegro); SHRUBS: *Calluno-Sarothamnietum* (Germany), *Paliuretum adriaticum* (Montenegro); GRASSLAND: *Corynephorion canescentis*, *Spergula vernalis Corynephorietum canescentis*, *Violo-Corynephorietum canescentis* (all Germany).

Natura 2000 habitats: Wooded dunes of the Atlantic, Continental and Boreal region (code 2180, Estonia, Netherlands, Sweden), Wooded dunes with *Pinus pinea* and/or *Pinus pinaster* (code 2270, Portugal), Pannonic inland dunes (code 2340, Slovakia), European dry heaths (code 4030, Slovakia), Pannonic sand steppes (code 6260, Hungary, Slovakia), Ponto-Sarmatic steppes (code 62C0, Ukraine), Dehesas with evergreen *Quercus* spp. (code 6310, Portugal), Western Taiga (code 9010, Finland, Sweden), Coniferous forests on, or connected to, glaciofluvial eskers (code 9060, Finland, Sweden), *Asperulo-Fagetum* beech forests (code 9130, Austria, Hungary), Eastern white oak woods (code 91AA, Macedonia), Pannonic woods with *Quercus petraea* and *Carpinus betulus* (code 91G0, Hungary), Pannonian-Balkan turkey oak - sessile oak forests (code 91M0, Serbia), Central European lichen Scots pine forests (code 91I0, Austria, Czech Republic), Moesian beech forests (code 91W0, Macedonia), *Quercus trojana* woods (code 9250, Macedonia), *Castanea sativa* woods (code 9260, Italy), *Quercus frainetto* woods (code 9280, Macedonia), *Quercus ilex* and *Quercus rotundifolia* forests (code 9340, Italy, Portugal), (Sub)Mediterranean pine forests with endemic black pines (code 9530, Greece), Mediterranean pine forests with endemic Mesogean pines (code 9540, Greece)

Soil requirements: The species inhabits nutrient-poor soils (often oligotrophic), mainly distinctly acid and with a very low content of organic matter. Soil types: many records exist for sandy sites, e.g. podzol, regosol (Portugal), but the fungus has also been found on brown soil, leached cernoziomic soil (Bulgaria) and above granite (Macedonia), seldom on alkaline soils, e.g. rendzina above limestone (Malta, Montenegro, Slovakia). In humid regions the species colonizes dry soils, but in the Mediterranean area it grows on soils with

a better water supply (because at very dry places no tree growth is possible?). Grain size: from gravel to clay (kaolin, Denmark). Litter layer: usually absent, sometimes thin.

Synanthropy: The species mainly occurs in forests, occasionally in plantations and in open biotopes with growing up trees. The colonized nutrient-poor soils are either natural or anthropogenic (often due to mining activities).

Indicator value: In many regions of Europe the species is a good indicator for nutrient-poor, acid and dry soils.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from early summer till late autumn (June-December). In Austria, fresh fruitbodies have been observed already in April, in Czech Republic in May. Because the basal part of the fruitbodies is rather persistent they can be found all over the year.

Frequency

Number of currently known sites: More than 1000.

Changes in frequency: In France, Netherlands, Poland and Portugal, no changes have been noticed. In Denmark, Hungary, Russia and UK, an increase in the number of sites is reported for the last 2-6 decades.

Threats and conservation

Threats: Sites are mainly threatened by eutrophication (mainly due to nitrogen deposits from air pollution, but e.g. also because of nutrient and litter accumulation in older forests).

Status of conservation: The species is red listed in Belgium (regional red list), Bulgaria, Denmark, France (regional red list), Germany, Hungary, Montenegro, Netherlands, Poland and Russia (regional red list). The fungus is protected by law in Croatia.

Battarrea phalloides (Dicks.: Pers.) Pers. s.lat.

Basidiomycota, Agaricales, Agaricaceae

Synonyms: *Lycoperdon phalloides* Dicks.: Pers., *Battarrea stevenii* (Libosch.) Fr.

Note 1: At least five spelling variants have been published for this genus. The name is dedicated to [Giovanni] Antonio Battarra, Italian clergyman, physician and mycologist (1714-1789). However, Persoon used the spelling “*Batarrea*” when describing the genus, in his *Synopsis Methodica Fungorum* (1801: 129), which is the sanctioning work for the Gasteromycetes. To respect both the spelling of the name of Battarra and Rec. 60B.1.(a) of the Code of Nomenclature (ending of generic names dedicated to persons), the only possible name is *Battarraea*. Rauschert (1986) suggested the conservation of *Battarraea* but this proposition has been rejected at the Berlin Congress, in 1987 (see Korf 1988: 463 and Coetzee & Eicker 1992).

It is not possible to use Art. 60.11 of the ICBN to change the suffix “ea” into “aea”, because it only refers to Rec. 60C.1, which concerns the specific and infraspecific epithets, and doesn’t refer to Rec. 60B.1, dealing with the generic names. On the other hand, Art. 60.1 allows the correction of typographical or orthographical errors in names or epithets. Many authors are now using this article to correct the name published by Persoon into “*Battarrea*” (e.g. Martín & Johannesson 2000: 67).

Note 2: *Battarrea phalloides* and *B. stevenii* are considered by several authors as separate species, difficult to distinguish (Calonge 1998). However, morphological and molecular studies have shown they must be considered as synonyms (Martín & Johannesson 2000, Jeffries & McLain 2004).



Brief description

A very recognizable gasteromycete, consisting of a hemispherical head becoming pulverulent when mature, carried by a fibrous foot which can reach more than 30 cm in length and is coming out of a gelatinous volva. It is mostly present in the southern half of Europe. It lives as a saprotroph on soil and leaf litter, in dunes, steppe-like grasslands and other kinds of biotopes, sometimes more or less anthropogenic. It is threatened by pesticides and afforestation.

Geography

Global distribution: Europe, Asia (Armenia, Georgia, Azerbaidjan, Kazakhstan, Iran, Turkey, Israel, Yemen, Socotra, Saudi Arabia, India, Pakistan, Mongolia, China), Africa (Canary Islands, Cape Verde Islands, Mauretania, Morocco, Algeria, Tunisia, Somalia, São Tome, Burundi, Kenya, Mozambique, Angola, Namibia, Zimbabwe, South Africa), North America (Mexico, USA, Canada), Central America (Puerto Rico), South America (Peru, Brazil, Chili), Oceania (Australia).

Bibliography: Cunningham (1942), Doidge (1950), Ahmad (1952), Dring & Rayss (1963), Dring (1964), Dring & Rayner (1966), Schwarzman & Filimonova (1970), Demoulin & Dring (1975), Beltrán Tejera & Wildpret de la Torre (1977), Dittmer (1978), Liu (1984), Urista et al. (1985), Dörfelt & Bumžaa (1986), Eckblad & Brochmann (1988), Binyamini (1989), Fan et al. (1994), Pegler et al. (1995), Watling et al. (1995), Teng (1996), Calonge (1996, 1998), Beltrán Tejera et al. (1998), Nieves-Rivera et al. (1998), Jacobson et al. (1999), Sharp & Pearce (1999), Martin & Johannesson (2000), Kreisel (2001), Corea (2002), Esqueda et al. (2002), Kreisel & Al-Fatmi (2004), Fraiture & Walley (2005), Sarasini (2005), Siller et al. (2005), Madrid (2007), Outcoudt et al. (2007), Sesli & Denchev (2008), Cortez et al. (2009), Costa Maia & Alves de Carvalho (2010), Moreno et al. (2010), Esqueda et al. (2011), Rimóczi et al. (2011), Tischhauser et al. (2011), Cantrell et al. (2012), Gvritishvili et al. (2012), Howladar et al. (2013), Martín et al. (2013), Sharp (2014).

Distribution in Europe: The species is mainly restricted to the lowlands but, in Macedonia, Russia and Spain, it is also found in lower mountain regions. It is indifferent as regards continentality (Rudnicka-Jeziarska 1991, Pegler et al. 1995, Calonge 1998, Sarasini 2005, Rimóczi et al. 2011).

Areal diagnosis for Europe: Southern half of Europe; mainly present in Atl. and Medit.; also present in C-Eur. (south), Alp., Therm. (more abundant in the steppic region of Hungary: puszta) and Step. (often old data); very rare in Sarm. (mainly old records); absent from Arct. and Bor.

Trophism, hosts and substrates

It is a saprotrophic species, usually decaying leaf litter and subterranean organic material (e.g. rhizomes and roots of Poaceae) and sometimes humus enriched with manure (Russia). In UK the



Battarreia phalloides

Photo Jan Vesterholt



Battarreia phalloides

Photo Jean-Paul Maurice

species was found several times associated with decaying wood (kind of wood not reported) and fruiting inside hollow trees facing the sun. Presumably three ecotypes exist, a widespread herbicolous, a humicolous (Russia) and an Atlantic lignicolous. See also Pegler et al. (1995), Sarasini (2005) and Howladar et al. (2013).

Habitat

Vegetation: The fungus occurs in steppes (Hungary, Russia, Ukraine), steppe-like grasslands (Germany), dunes (France, Italy) and also on sunny edges and clearings in different kinds of woodlands: *Robinia* (Hungary and Ukraine), *Populus*, *Salix* (Bulgaria), mixed *Pinus* and *Robinia* forest (Serbia), *Cedrus*, *Cupressus*, *Juniperus*, *Pinus* (France), *Cupressus* (Greece and Ukraine), *Juniperus* (Macedonia). Rather often the species colonizes anthropogenic biotopes as hedges, roadsides, gardens, parks and cemeteries (e.g. France, Poland, UK); in Germany it has repeatedly been found in nitrophilous coppices with *Sambucus nigra*, *Urtica dioica*, etc. In Russia, it has also been observed on old dunghills. See also Thiel & Zimmermann (1994), Jacobson et al. (1999) and Franchi et al. (2001).

Syntaxa of vegetation: FORESTS: *Junipero-Populetum albae* (Hungary), *Juniperetum excelsae*, *Quercus-Carpinetum orientalis*, *Coccifero-Carpinetum orientalis* (all Macedonia), *Robinietaea* (Slovakia); SHRUBS: *Syringetum vulgaris* (Germany), *Hippophao-Sambucetum* (Belgium), *Artemisietaea vulgaris* (Slovakia)

Natura 2000 habitats: Coastal dunes with *Juniperus* spp. (code 2250, France), Pannonic sand steppes (code 6260, Hungary), Endemic forests with *Juniperus* spp. (code 9560, Macedonia)

Soil requirements: The fungus prefers sandy soils, but from Czech Republic it is also recorded on clay and cretaceous rocks. In humid areas, dry soils are colonized; in more semi-

arid areas (e.g. parts of Spain), the soils are comparatively wet. The pH-value is neutral to basic. The litter layer is absent to rather thick. In Macedonia, the species has repeatedly been observed on a sandy soil polluted by cormorant guano (Martín et al. 2013).

Synanthropy: Especially in temperate Europe, the species rather often occurs in anthropogenic habitats.

Indicator value: In humid areas the species indicates sunny dry places.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from summer till early winter (June-December). Especially the stipe is rather persistent, allowing identification all over the year.

Frequency

Number of currently known sites: About 160.

Changes in frequency: There are no indications for strong and large-area frequency changes. A decrease of the species is reported from Hungary and Poland.

Threats and conservation

Threats: Sites are threatened by eutrophication, pesticides and afforestation.

Status of conservation: The species is red listed in Austria, Bulgaria, Czech Republic, France, Germany, Hungary, Macedonia, Poland, Romania, Russia (regional red lists), Serbia, Slovakia, Spain and UK. It is protected by law in Serbia and UK. The species is included in the IUCN *Global Fungal Red List Initiative* (see their web-site).

Montagnea radiosa (Pall.) Šebek

Basidiomycota, Agaricales, Agaricaceae

Synonyms: *Montagnites radiosus* (Pall.) Henn., *Montagnea arenaria* (DC.) Zeller, *Montagnites candollei* Fr.

Note: *Montagnea* Fr. (1836) has priority over *Montagnites* Fr. (1838), as already mentioned by Zeller (1943). The combination in the genus *Montagnea* has been made by Šebek (1954), the combination by Rauschert (1983: 26) is superfluous.

Brief description

A remarkable secotioid and coprinoid fungus, with a volva at the base of the stem and black contorted gills, laterally inserted on the top of the stem and becoming almost entirely free. The species is very rare and lives in the southern half of Europe, as a terricolous saprotroph, in dry and more or less sandy places such as dunes and steppe or steppe-like biotopes. This thermophilic fungus is characteristic for dry and warm grassy habitats. It is mainly threatened by intensification or cessation of grassland management, eutrophication and afforestation.

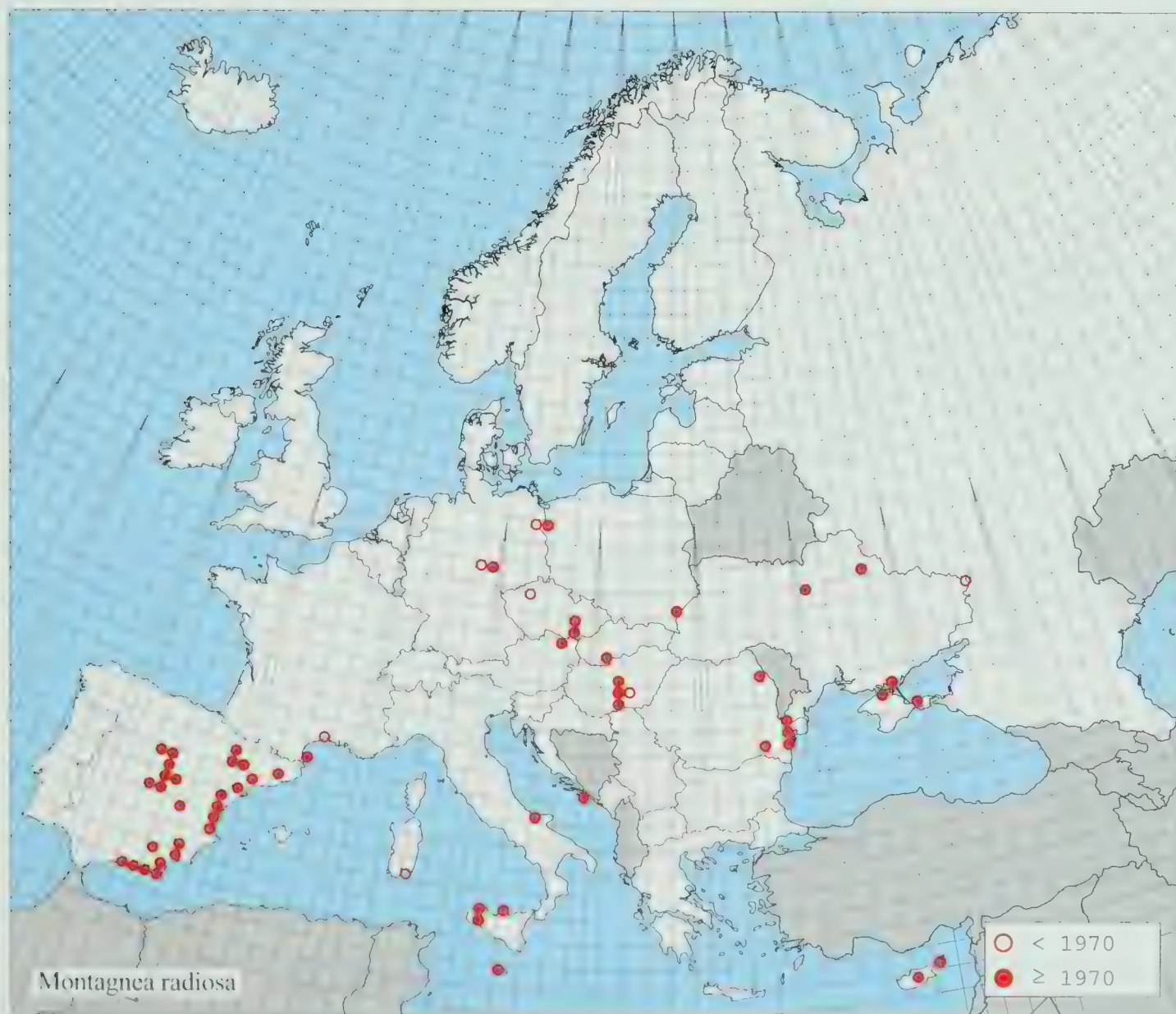
Geography

Global distribution: Europe, Asia (Armenia, Georgia, Kazakhstan, Turkey, Israel, Iraq, Iran, Yemen, Saudi Arabia, Afghanistan, Kazakhstan, Tajikistan, Turkmenistan, Kirghizstan, Uzbekistan, Siberia, Pakistan, India, Mongolia, China), Africa (Canary Islands, Cape



Montagnea radiosa

Photo Paco Sáinz



Verde Islands, Mauritania, Morocco, Algeria, Tunisia, Libya, Egypt, Chad, Kenya, South Africa), North America (USA, Mexico), Central America (Cuba, Puerto Rico), South America (Chili, Argentina, Galapagos Islands), Oceania (Australia, New Zealand).

Bibliography: Zeller (1943), Doidge (1950), Ahmad (1952), Šmarda (1952), Dring & Rayss (1963), Rauschert (1964), Dring & Rayner (1966), Singer (1968), Fekblad (1970), Schwarzman & Filimonova (1970), Dörfelt (1974), Beltrán Tejera & Wildpret de la Torre (1977), Dörfelt (1978), Liu (1984), Urista et al. (1985), Dörfelt & Bumžaa (1986), Fekblad & Brochmann (1988), Reid & Eicker (1991), Mornand (1994), Dörfelt & Richter (1996), Teng (1996), May & Wood (1997), Beltrán Tejera et al. (1998), Chen (1999), Mao (2000), Stasińska & Praps (2002), Kreisel & Al-Fatmi (2004), Sarasini (2005), Iorca & Muñoz (2006), Nieves-Reveti & Aime (2006), Dörfelt & Gube (2007), Sesli & Denehev (2008), Moreno et al. (2010), Rimóczi et al. (2011), Camino Vilaró (2012).

Distribution in Europe: The fungus mainly occurs in the lowlands, seldom also in lower mountain regions (Spain) (Rudnicka-Jezierska 1991, Sarasini 2005, Rimóczi et al. 2011).

According to Kreisel (2001), the species is also present in Greece, Russia and Crete, but we did not receive nor find any data concerning its presence in those territories.

Areal diagnosis for Europe: Mainly present in Medit. and Step. as well as in steppic regions of Therm. (Hungary and Romania) and Sarm. (woody steppe); very rare in C-Eur. (declining); absent from Arct., Bor., Atl. and Alp.

Trophism, hosts and substrates

The fungus is a terricolous saprotroph living on dead plant material (rhizomes and roots of Poaceae?).

Habitat

Vegetation: The fungus inhabits dry and more or less sandy places, e.g. coastal (Malta, Spain) and inland dunes (e.g. Hungary, Slovakia), xerothermic pastures (Poland, Slovakia), steppe-like vegetation with *Stipa* on slopes with southern exposure (Germany, Poland). In more continental Europe, it occurs in steppes (Austria, Ukraine) and steppe meadows (Ukraine, among *Festuca valesiaca*). Very seldom it was found in more or less anthropogenic habitats as *Robinia* plantation (Poland), recultivated ash area (Czech Republic) and waysides (Ukraine). See also Rauschert (1964), Dörfelt (1978), Dörfelt & Richter (1996), Sarasini (2005) and Stasińska (2008).

Syntaxa of vegetation: DUNES: *Ammophilion arenariae* (France), *Cakiletea*, *Ammophiletea* (both Malta); GRASSLANDS: *Festuco-Stipetum* (Germany), *Festucion valesiaca* (Germany, Slovakia), *Cirsio-Brachypodium pinnati* (Poland), *Festucetalia vaginatae* (Hungary), *Ceratocarpo-Euphorbion stepposae* (Romania), *Festucion valesiaca* (Slovakia), *Crucianellion maritimae* (Croatia). According to Rimóczi et al. (2011), also in *Junipero-Populetum albae*.

Natura 2000 habitats: Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) (code 2120, France, Malta, Spain), *Crucianellion maritimae* fixed beach dunes (code 2210, Croatia), Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (code 6210, Poland, Slovakia), Pannonic sand steppes (code 6260, Hungary, Ukraine), Ponto-Sarmatic steppes (code 62C0, Ukraine).

Soil requirements: The species mainly colonizes sandy, neutral to slightly basic dry soils. It has also been observed on wet soils in Spain. Soil types: alluvial sands, loess (e.g. Austria), brown soil (Poland), cernoziomic soils (Romania), ash (Czech Republic). Nitrogen content: seems to be low to moderate. Litter layer: absent or thin.

Synanthropy: The species inhabits a wide range of biotopes, from natural and near-natural (dunes, steppes) to semi-natural (grasslands) and was found only very rarely in habitats considerably influenced by man.

Indicator value: It is a thermophilic fungus, characteristic of dry and warm grassy habitats.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from early summer till autumn (May-October).

Frequency

Number of currently known sites: About 70.

Changes in frequency: In Slovakia, a decrease during the last decades is reported (no record after 1987). In Hungary, Poland and Spain no changes have been noticed.

Threats and conservation

Threats: Sites are mainly threatened by intensification or cessation of grassland management, eutrophication and afforestation. See also Dörfelt & Richter (1996).

Status of conservation: The species is red listed in Austria, Czech Republic, Germany, Hungary, Malta, Poland, Slovakia and Spain.

Torrendia pulchella Bres.

Basidiomycota, Agaricales, Amanitaceae

Synonym: *Amanita torrendii* Justo

Excluded: *Amanita pulchella* S. Imai, *Amanita pulchella* (Cooke & Massee) E.-J. Gilbert

Note: Traditionally, the genus has been included in the Gasteromycetes. However, it is known since a long time (Malençon 1955, Bas 1975) that the genus *Torrendia* is close to the genus *Amanita*. Molecular studies have confirmed that hypothesis and shown the nesting in *Amanita* sect. *Caesarea* (Justo et al. 2010). The name *Amanita pulchella* is preoccupied by *A. pulchella* S. Imai and by *A. pulchella* (Cooke & Massee) E.-J. Gilbert and, consequently, Justo et al. (2010) published the new name “*Amanita torrendii* (Bres.) Justo nom. nov.” However, *A. torrendii* is a nom. nov. and Bresadola should not be cited as the author of the basionym.

Brief description

A small white gasteromycete, corresponding to an amanita which became secotioid. Its sporophores are first spherical and then composed of a globose or more or less flattened head, carried by a cylindrical stem the base of which being inserted into a volva. They are produced in spring and in autumn. It is typically a Mediterranean and sub-Mediterranean species, forming ectomycorrhizae with several species of pines (*Pinus*), oaks (*Quercus*) and *Cistus*, in various biotopes such as forests, dunes, macchia and garrigues. It is mostly threatened by deforestation, overgrazing and fires.

Geography

Global distribution: Europe, Asia (Turkey), Africa (Atlas mountains in Morocco and Algeria).



Torrendia pulchella

Photo Anton Hausknecht

Bibliography: Beller & Bon (1966), Watling & Işıloğlu (1991), Miller & Horak (1992), Calonge & Almeida (1992), Calonge (1997), Kreisel (2001), Neville & Poumarat (2004), Sarasini (2005), Sesli & Denchev (2008), Díaz (2012).

Distribution in Europe: The species mainly occurs in the lowlands, seldom above 1200 m (Spain) (Sarasini 2005).

As indicated by Demoulin (1983) and Moyersoen & Demoulin (1996), the distribution is rather similar to the distribution of *Quercus suber*. The distribution of *Pinus pinaster*, another of its main hosts, is also very close. According to Malençon & Bertault (1970), the species is a characteristic element of the Lusitano-Mauritanian domain.

Areal diagnosis for Europe: Mostly in Medit. (especially Spain), also in southern Atl.; absent from the other domains.

Trophism, hosts and substrates

It is an ectomycorrhizal fungus living in symbiosis with the following trees and shrubs: *Pinus pinaster*, *pinea*, *Quercus ilex*, *suber*, *pyrenaica?*, *robur?*, *rotundifolia?* and *Cistus* spp. (*C. monspeliensis* and *salvifolius*), possibly also with *Castanea sativa* (Spain) (Beller & Bon 1966, Moyersoen & Demoulin 1996, Sarasini 2005, Comandini et al. 2006, Diaz 2012).



Habitat

Vegetation: The species only occurs in Mediterranean and Sub-Mediterranean forests and scrublands. It was found in deciduous and sclerophyllous oak woods, in pine forests, coastal wooded dunes with pines, in macchia and in garrigues with *Cistus*. After Demoulin (1983), it is a southern species growing on acid soils, in relatively rainy regions, which requirements correspond with the ecological optimum of *Quercus suber*.

Syntaxa of vegetation: FORESTS: *Ericion arboreae*, *Quercenion suberis*, *Pino-Quercetum suberis* (all France); GRASSLAND: *Corynephorion canescentis* (France).

Natura 2000 habitats: Wooded dunes of the Atlantic, Continental and Boreal region (code 2180, France), Wooded dunes with *Pinus pinea* and/or *Pinus pinaster* (code 2270, Portugal), Galicio-Portuguese oak woods with *Quercus robur* and *Quercus pyrenaica* (code 9230, Spain), *Castanea sativa* woods (code 9260, Spain), *Quercus suber* forests (code 9330, France, Spain), *Quercus ilex* and *Quercus rotundifolia* forests (code 9340, Spain), Mediterranean pine forests with endemic Mesogean pines (code 9540, Spain).

Soil requirements: Colonized soils are sandy, acid to more or less neutral, and often clearly dry (podzols and regosols, from Spain wet soils are reported). Nitrogen content: low to moderate. Litter layer: absent or poorly developed.

Synanthropy: The fungus occurs in natural and semi-natural habitats and avoids environments strongly influenced by man.

Indicator value: It is a characteristic fungus of Mediterranean wooded biotopes on sandy soils.

Occurrence of fruitbodies (phenology)

Basidiocarps occur in spring (March-June) and in autumn (October-November).

Frequency

Number of currently known sites: About 100.

Changes in frequency: In France no changes have been noticed. In Spain an increase of sites is reported for the last 3 decades.

Threats and conservation

Threats: Sites are threatened e.g. by deforestation, overgrazing and fires. After Calonge (1997), the species is in a process of expansion in the Iberian Peninsula.

Status of conservation: The species is red listed in France, Italy and Spain. About 90 percent of the currently known sites are located in Spain. See also Dahlberg & Croneborg (2003, 2006).

Bovista paludosa Lév.

Basidiomycota, Agaricales, Agaricaceae

Synonyms: *Calvatia paludosa* (Lév.) De Toni, *Bovistella paludosa* (Lév.) Pat., *Mycenastrum lycoperdoides* Cooke, *Bovistella lycoperdoides* (Cooke) Lloyd, *Scleroderma cookei* De Toni, *Lycoperdon bubakii* Bres., *Bovistella humidicola* Bowerman (synonymy mainly after Kreisel 1967).

Note: When combining the species in the genus *Bovistella*, Lloyd (1902, *Mycological Notes* 9: 88) quotes a letter from Patouillard, who must therefore be considered as the author of the combination.

Brief description

A small pyriform whitish puffball, mostly present in boreal and central Europe, as well as in the Alps. It is a saprotrophic fungus growing among mosses in alkaline to neutral fens. The species is threatened by large-scale draining of bogs and mires and by eutrophication.

Geography

Global distribution: Europe, Asia (Altai, Siberia, Himalaya, India), North America (USA, Canada).

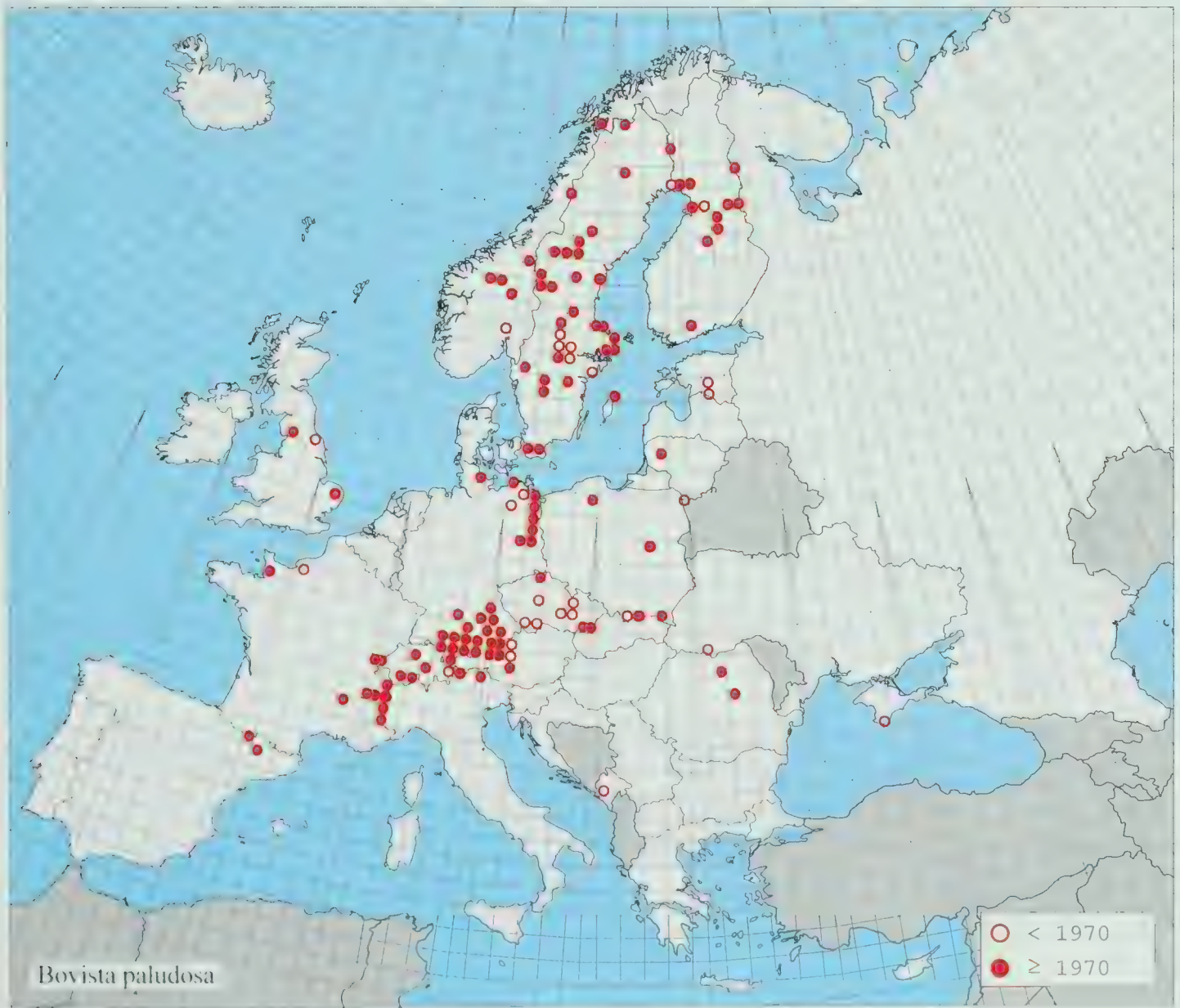
Bibliography: Kreisel (1962, 1967), Björkbäck & Gustafsson (1980), Gross et al. (1980), Rudnicka-Jezierska (1991), Pegler et al. (1995), Calonge (1998), Kreisel (2001), Wojewoda (2002), Sarasini (2005), Bresinsky & Dörfelt (2008), Jamoni (2008), Gorbunova (2010), Stasińska (2011).

Distribution in Europe: The species mainly occurs in the lowlands, occasionally in lower mountain regions (e.g. Poland, Romania, Ukraine) and seldom above 1200 m (Austria, France, Spain). Jamoni (2008) mentions collections in Alpine environment, up to an altitude of 2200 m.



Bovista paludosa

Photo Anton Havelkovič



Areal diagnosis for Europe: Mainly Bor., C-Eur. and Alp.; also present in Sarm. (west) and Atl.; very rare in Arct. and Therm. (an old record in S Ukraine); absent from Step. and Medit.

Trophism, hosts and substrates

It is a saprotrophic fungus decaying dead plant material, probably mainly mosses (e.g. *Aulacomnium palustre*, *Calliergoniella cuspidata*, *Drepanocladus* spp., *Sphagnum* spp.), but surely also remnants of seed plants as sedges (*Carex* spp.), other Cyperaceae (e.g. *Eriophorum* spp., *Trichophorum cespitosum*) and Poaceae (e.g. *Molinia caerulea*). It is remarkable that fructifications often appear among mosses.

Habitat

Vegetation: The fungus inhabits a rather wide range of wet mossy habitats. Records exist for mires (e.g. Finland, UK), alkaline fens (Germany, Sweden), spring fens (Estonia), wet heaths (UK), damp or boggy peat meadows (e.g. Poland) and for a meadow in a mountain forest (Ukraine).

The species most often occurs in alkaline to neutral fens and wet meadows (characteristic plants are e.g. *Carex davalliana*, *Molinia caerulea*, *Parnassia palustris*), but mires are

also suitable habitats (noteworthy seed plants are e.g. *Carex rostrata*, *Eriophorum angustifolium* and *Trichophorum cespitosum*). Jamoni (2008) also cites the edge of streamlets as a suitable habitat. The species mainly avoids oligotrophic and strongly acid mires (records from Germany as *Sphagnetum magellanicum*). Associated fungi are e.g. *Entoloma griseocyanum*, *E. mougeotii* and *Lycoperdon caudatum* (Germany). See also Kreisel (1962, 1967, 2001), Björkback & Gustafsson (1980), Alpago Novello (2002), Wojewoda (2002), Sarasini (2005), Adamčík & Ripková (2006) and Bresinsky & Dörfelt (2008).

Syntaxa of vegetation: BOG AND SWAMP VEGETATION: *Oxycocco-Sphagnetum*, *Eriophoro-Trichophoretum cespitosum*, *Sphagnetum magellanicum*, *Cratoneurion commutati*, *Caricion davallianae*, *Orchio-Schoenetum nigricantis*, *Primulo-Schoenetum ferruginei*, *Scheuchzerio-Caricetea fuscae*, *Caricion fuscae*, *Calthion*, *Juncetum subnodulosum*, *Molinion caeruleae*, *Cladietum marisci* (all Germany), *Valeriano-Caricetum flavae* (Poland), *Caricetalia davallianae*: *Caricion incurvae*, *Eriophorion scheuchzeri*, *Caricion bicoloris-atrofuscae* (all France), *Caricetum diandrae* (Romania).

Natura 2000 habitats: *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) (code 6410, Czech Republic, Germany, Romania), Active raised bogs (code 7110, Austria, Germany, Slovakia, Switzerland), Transition mires and quaking bogs (code 7140, Czech Republic, Finland, Germany, Slovakia), Fennoscandian mineral-rich springs and springfens (code 7160, Finland, Sweden), Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* (code 7210, Germany, Switzerland), Alkaline fens (code 7230, Estonia, Finland, France, Germany, Lithuania, Macedonia, Poland, Sweden, UK), Alpine pioneer formations of *Caricion bicoloris-atrofuscae* (code 7240, France).

Soil requirements: The species colonizes more or less pure organotrophic substrates (peat in a wide sense). PH-value: mainly clearly basic, only exceptionally acid. Nitrogen content: from obviously low (more or less oligotrophic) to moderately low (mesotrophic). In Estonia the nitrogen content is reported as high.

Synanthropy: The species mainly occurs in natural and near-natural habitats (fens and mires), less often in semi-natural ones (extensively used meadows).

Indicator value: The fungus is a good indicator for undisturbed or only weakly perturbed fens and mires.

Occurrence of fruitbodies (phenology)

Basidiocarps are mainly produced from early summer till autumn (June-October), seldom already in May (Czech Republic).

Frequency

Number of currently known sites: About 150.

Changes in frequency: In Czech Republic, Estonia, Finland, France, Germany, Poland and Sweden, a decrease has been noticed for the last 50 years (e.g. no records in Czech Republic since 1985, in Estonia since 1959, in Poland since the early 1970's).

Threats and conservation

Threats: The number of sites decreased, mainly as a consequence of large-scale draining of bogs and mires. The species is also threatened by eutrophication (e.g. because nutrient enrichment suppresses mosses by promoting the development of seed plants).

Status of conservation: The species is red listed in Austria, Czech Republic, Estonia, Finland, France, Germany, Iberian Peninsula (Spain + Portugal), Montenegro, Norway, Poland, Serbia, Slovakia, Sweden, Switzerland and UK. See also Dahlberg & Croneborg (2003, 2006).

Tulostoma niveum Kers.

Basidiomycota, Agaricales, Agaricaceae

Brief description

A rather small gasteromycete, producing white sporophores composed of a cylindrical stem wearing a globose head. An opening in the peridium, at the top of the head, allows emission of spores from the pulverulent gleba, hence the name “stalk puffballs” given to this group. The species is almost restricted to the northernmost parts of Central-European and Atlantic domains. It lives as a humicolous saprotroph, in open mossy biotopes, on calcareous substrates. It is mainly threatened by eutrophication of sites.

Geography

Global distribution: not known outside Europe.

Distribution in Europe: The species exclusively occurs in the lowlands (Pegler et al. 1995).

Areal diagnosis for Europe: Almost exclusively in Atl. (mostly Boreo-Atlantic sector) and C-Eur. (Boreo-nemoral sector); very rare in Bor. and Sarm. (both one record in Finland); absent from Arct., Alp., Therm., Medit. and Step.





Tulostoma niveum

Photos Mikael Jeppson

Trophism, hosts and substrates

The species is a saprotroph living in dense moss tussocks on calcareous rocks and boulders. It must be regarded as bryophilous and humicolous.

Habitat

Vegetation: This extreme stenoeccious fungus occurs in different open mossy biotopes on calcareous substrates. It has mainly been found at rocky sites with dominating mosses, occasionally in xerophytic grasslands and heaths (Kers 1978, Fleming et al. 1998, Jordal & Johnsen 2009).

Syntaxa of vegetation: *Ctenidieta mollusci* within the *Alysso-Sedion albi* (Sweden)

Natura 2000 habitats: Alpine and Boreal heaths (code 4060, UK), Rupicolous calcareous or basophilic grasslands of the *Alysso-Sedion albi* (code 6110, Sweden), Fennoscandian lowland species-rich dry to mesic grasslands (code 6270, Finland), Nordic alvar and precambrian calcareous flatrocks (code 6280, Sweden), Calcareous and caleshist screes of the mountain to alpine levels (code 8120, UK), Calcareous rocky slopes with chasmophytic vegetation (code 8210, Finland), Limestone pavements (code 8240, Sweden)

Soil requirements: At the sites distinct soils are not present. The fungus colonizes humus at the basis of moss tussocks on calcareous substrates (e.g. limestone, caleshist).

Symbiotrophy: The fungus only occurs in natural and near-natural open biotopes.

Indicator value: It is a very good indicator for mossy microhabitats on calcareous rocks.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced in spring (April-May) and in the summer-autumn period (Au-

gust-November) (Fleming et al. 1998). Because of their comparatively high persistence they can be found all over the year.

Frequency

Number of currently known sites: 34 (a large majority of which in Sweden and UK).

Changes in frequency: In Sweden a decrease is reported for the last 100 years. In UK an increase in the number of sites is reported.

Threats and conservation

Threats: The fungus is mainly threatened by eutrophication of sites, which favours the growth of seed plants and suppresses mosses, and by cessation of grazing, which allows the development of trees, especially *Betula*. Trampling by man has also a negative impact.

Status of conservation: The species is red listed in Finland, Sweden and UK. The species is included in the IUCN *Global Fungal Red List Initiative* (see their web-site). See also Dahlberg & Croneborg (2003, 2006) and Jeppson (2005).

Myriostoma coliforme (With: Pers.) Corda

Basidiomycota, Geastrales, Geastraceae

Synonyms: *Lycoperdon coliforme* With.: Pers., *Geastrum coliforme* (With.: Pers.) Pers., *Polystoma coliforme* (With.: Pers.) Gray, *Myriostoma anglicum* Desv. and (fide Sunhede 1989) *Geastrum columnatum* Lév.

Note 1: The first author to mention the species after the starting point of botanical nomenclature (1753) is Withering W. (1776) *A botanical arrangement of all the vegetables naturally growing in Great Britain* (1st éd.) 2: 783. Under the name *Lycoperdon coliforme*, Withering cites a description by John Ray (= Rajus Joannes): "Ray's Syn. 28". Fries (*Syst. mycol.* 3: 12) also cites the species under *G. coliformis*: "Dood. in Raji Hist. 3. p. 20 - Dill. in Raji syn. 3. p. 27. excl. syn.". Those citations very probably refer to the *Historia plantarum species*, vol. 3 - Supplementum, published in 1704 and to the third edition of the *Synopsis methodica stirpium Britannicarum* of Ray, edited by Dillenius in 1724. Those two works have been published before the starting point of the botanical nomenclature.

Dickson J. (1785) *Fasciculus plantarum cryptogamicarum Britanniae* I: 24, tab.3, fig. 4, reused the name of Withering (*Lycoperdon coliforme*), without citing that author but citing Ray: "Raj. Syn. p. 28 n. 12.". The name of Withering remained overlooked because, when combining the species in the genus *Myriostoma*, Corda (1842, *Anleitung zum Studium der Mykologie* II: LXXXI; see also III: 105) cites Dickson and not Withering.

Note 2: The genus *Myriostoma* has been described by Desvaux (1809: 104). That author cites *Myriostoma anglicum* as a species belonging to that genus but immediately mentions *Lycoperdon coliforme* Dicks. and



Geastrum coliforme Pers. So, *Myriostoma anglicum* is just a new and superfluous name which, moreover, is not sanctioned by Persoon.

Brief description

An earthstar (gasteromycetes) easy to identify because of the numerous pores in the endoperidium (hence the name „pepper pot“). It is a rare species rather widely distributed in Europe, except in the northern part. It is a saprotrophic species living on leaf litter on rich soils, in quite a large diversity of habitats, open as well as wooded, including anthropogenic biotopes. Dried fruitbodies are observable throughout the year.

Geography

Global distribution: Europe, Asia (Armenia, Georgia, Kazakhstan, Turkey, Israel, Socotra, Afghanistan, Iran, Pakistan, India, China), Africa (Canary Islands, Morocco, Algeria, Kenya, South Africa), North America (Canada, USA, Mexico), Central America (Costa Rica), South America (Ecuador [Galapagos Islands], Venezuela, Argentina, Brazil, Chili), Oceania (Australia, Hawaii).

Bibliography: Wright (1949), Doidge (1950), Smith (1951), Dring & Rayner (1966), Eckblad (1970), Schwarzman & Filimonova (1970), Dörfelt et al. (1979), Reid et al. (1980), Kers (1982), Smith & Ponce de Leon (1982), Urista et al. (1985), Sunhede (1989), Calonge & Almeida (1992), Violante et al. (1994), Jalink (1995), Pegler et al. (1995), La Rocca & Anastase (1997), Beltrán Tejera et al. (1998), Calonge (1998), Mao (2000), Kreisel (2001), Baseia & Galvão (2002), May et al. (2003), Kreisel & Al-Fatmi (2004), Guinberteau (2005), Rees et al. (2005), Sarasini (2005), Sesli & Denchev (2008), Outcoumit et al. (2009), Costa Maia & Alves de Carvalho (2010), Doğan et al. (2011), Esqueda et al. (2011), Alexov et al. (2012), Gvritishvili et al. (2012), Hensel (2012), Iturriaga & Minter (2012), Minter & Perdomo (2012).

Distribution in Europe: The species mainly occurs in the lowlands, occasionally also in lower mountain regions (e.g. Croatia, Italy, Romania) (Rudnicka-Jezierska 1991, Pegler et al. 1995, Pegler et al. 1995, Jalineck 1995, Calonge 1998, Sarasini 2005, Rimóczi et al. 2011).

According to Kreisel (2001), the species has also been observed in Denmark but (Kreisel, comm. pers.) that mention is based on Pegler et al. (1995: 113) and it could be a lapsus for Sweden. Anyway, we did not receive nor find any data concerning the presence of *Myriostoma* in Denmark.

Areal diagnosis for Europe: mainly Atl., C-Eur., Therm. (a.o. steppic regions of Hungary and Romania), Medit. and Step.; very rare in Sarm. (woody steppe) and Alp.; absent from Arct. and Bor.

Trophism, hosts and substrates

It is a terricolous saprotrophic fungus decaying leaf litter and other organic material.

Habitat

Vegetation: The species occurs in open as well as in wooded biotopes. It colonizes grassy habitats, e.g. pastures, xerophytic grasslands (e.g. Austria, Bulgaria), steppes (Ukraine) and coastal dunes (France, Netherlands, UK), as well as different kinds of woodlands, frequently in deciduous forests: often under the nitrogen accumulating *Robinia* (e.g. Romania, Serbia, Slovakia), moreover under e.g. *Castanea* (Italy), *Populus*, *Ulmus* (Ukraine), *Quercus*, *Populus* (Russia), in Greece e.g. in alluvial forests, also in sclerophyllous forests,



Myriostoma coliforme

Photo Jacques Guinberteau

scrubs and macchia (*Paliurus spina-christi* in Bulgaria, *Quercus ilex* and *Q. suber* in Italy), in mixed forests (*Quercus ilex* and *Abies borisii-regis* in Greece, *Fraxinus ornus*, *Quercus suber* and *Q. ilex* in Italy, see La Rocca & Anastase 1997) and coniferous woodlands (Italy). Rather numerous records concern anthropogenic habitats, e.g. nitrophilous coppices (e.g. France, Germany, Poland, Russia), ruderal vegetation (Hungary), roadsides (e.g. Croatia, Slovakia), hedges, gardens (Greece, UK), arboretum (Ukraine). The species is also probably thermophilic (La Rocca & Anastase 1997). See also Dörfelt et al. (1979), Kers (1976, 1982), Sunhede (1989), Guinberteau (2005), Sarasini (2005), Stasińska (2008), Rimóczi et al. (2011), Hensel (2012) and Dörfelt & Gube (2014).

Syntaxa of vegetation: FORESTS: *Ulmion minoris*, *Populenalia albae* (both Germany, France), *Viola odoratae-Ulmetum* (Poland), *Querco-Carpinetum orientalis* (Bulgaria, Macedonia), *Juniperetum excelsae* (Macedonia), *Carpino-Fagetum*, *Bromo sterili-Robinetum pseudoacaciae* (both Romania, Slovakia), *Populeto-Quercetum roboris* (Serbia); SHRUBS: *Syringetum vulgaris* (Bulgaria, Germany); RUDERAL VEGETATION: *Onopordetalia acanthii*, *Carthametalia lanati* (both France)

Natura 2000 habitats: Fixed coastal dunes with herbaceous vegetation (grey dunes) (code 2130, UK), Atlantic decalcified fixed dunes (code 2150, UK), Dunes with *Hippophae rhamnoides* (code 2160, Netherlands), Dunes with *Salix repens* ssp. *argentea* (*Salicion arenariae*) (code 2170, UK), Wooded dunes of the Atlantic, Continental and Boreal region (code 2180, Netherlands), Coastal dunes with *Juniperus* spp. (code 2250, Portugal, UK), Inland dunes with open *Corynephorus* and *Agrostis* grasslands (code 2330, Romania), Dry Atlantic coastal heaths with *Erica vagans* (code 4040, UK), Arborescent matorral with *Juniperus* spp. (code 5210, Bulgaria), Pannonic sand steppes (code 6260, Hungary, Serbia, Slovakia), Calcareous rocky slopes with chasmophytic vegetation (code 8210, Sweden), Siliceous rocky slopes with chasmophytic vegetation (code 8220, Sweden, Switzerland), *Luzulo-Fagetum* beech forests (code 9110, Austria), *Gallio-Carpinetum* oak hornbeam forests

(code 9170, Austria, Ukraine), *Castanea sativa* woods (code 9260, Italy), *Quercus ilex* and *Quercus rotundifolia* forests (code 9340, Croatia, Italy), Riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *Ulmus minor*, *Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmion minoris*) (code 91F0, France), *Salix alba* and *Populus alba* galleries (code 92A0, France, Italy).

Soil requirements: The fungus inhabits often sandy, more or less basic soils, seldom clayey (Bulgaria, Greece) and acidic ones (Spain). Noteworthy is the preference of the fungus for rather eutrophic and nitrogen-rich sites (from Macedonia reported on nitrogen-poor soils). In humid areas the soils are distinctly dry, but in semiarid regions comparatively damp to wet. In Serbia the species was found on very wet and nitrogen rich soil. Soil types: e.g. brown soil (Bulgaria), loess. Geologic substrate: e.g. limestone, granite (Bulgaria). Grain size: always large, from gravel (Slovakia) to sand. Litter layer: thin to thick.

Synanthropy: The fungus rather often occurs in anthropogenic nutrient-rich habitats, especially in temperate Europe.

Indicator value: In humid areas the fungus indicates sunny dry places well supplied with nutrients.

Occurrence of fruitbodies (phenology)

As basidiocarps are rather persistent, they can be found and identified all over the year.

Frequency

Number of currently known sites: About 150, among which nearly 80 percent are located in France, Netherlands and Spain.

Changes in frequency: There are no indications for strong and large-area frequency changes. A decrease of the species is reported from France, Netherlands (slight) and Poland during the last 5 decades. Considered as extinct in Britain since 1880, the species has been found again in 2006 and 2010. In Greece, Macedonia, Serbia and Spain, no changes have been noticed. In Hungary, Germany (Dörfelt & Gube 2014), Russia and Slovakia, an increase in the number of sites is reported.

Threats and conservation

Threats: The fungus is rather well adapted to eutrophication and habitat disturbances. At open sites the species seems to be threatened by afforestation.

Status of conservation: The species is red listed in Austria, Bulgaria, Croatia, Czech Republic, France, Germany, Hungary, Iberian Peninsula (Spain + Portugal), Netherlands, Poland, Romania, Russia (regional red lists), Serbia, Slovakia, Sweden, Switzerland, Ukraine and UK (in Macedonia in a preliminary red list). It is protected by law in Croatia, Serbia and Slovakia. The species is included in the IUCN *Global Fungal Red List Initiative* (see their web-site). See also Dahlberg & Croneborg (2003, 2006).

Craterellus melanoxeros Desm.

Basidiomycota, Cantharellales, Cantharellaceae

Synonym: *Cantharellus melanoxeros* Desm.

Excluded: *Craterellus ianthinoxanthus* (Maire) Pérez-De-Greg. (syn. *Cantharellus ianthinoxanthus* (Maire) Kühner). That species is considered as a synonym by some authors (Damblon et al. 1974, 1975; Hansen & Knudsen 1997) but there is now quite a large agreement to treat it as a separate species (Monthoux & Röllin 1978, Cherubini & Dell’Orbo 1993, Braccini & Cherubini 1995, Neville & Alpago-Novello 1998, Pérez-De-Gregorio et al. 2000). *C. melanoxeros* has citric or sulphur yellow colours on the cap and stem and its flesh is slowly darkening when cut or bruised. *C. ianthinoxanthus* has a more orange colour and is not blackening.

Note: *Cantharellus melanoxeros* is cited in the index of Fries’s *Systema mycologicum*, but without any page number and the species is not treated in the part of the “Systema” devoted to cantharels. Therefore, that name should probably not be considered as sanctioned.

Brief description

A chanterelle with a sulphur yellow cap and stem contrasting with the grey pinkish-lilac hymenophore; the flesh is slowly blackening when cut. It is mainly present in the Atlantic, Central-European and Alpine domains. It forms ectomycorrhizae with Fagaceae, mainly beech (*Fagus sylvatica*) and oaks (*Quercus*). It is mostly threatened by intensification of silvicultural practices and by nitrogen deposition from air pollution.

Geography

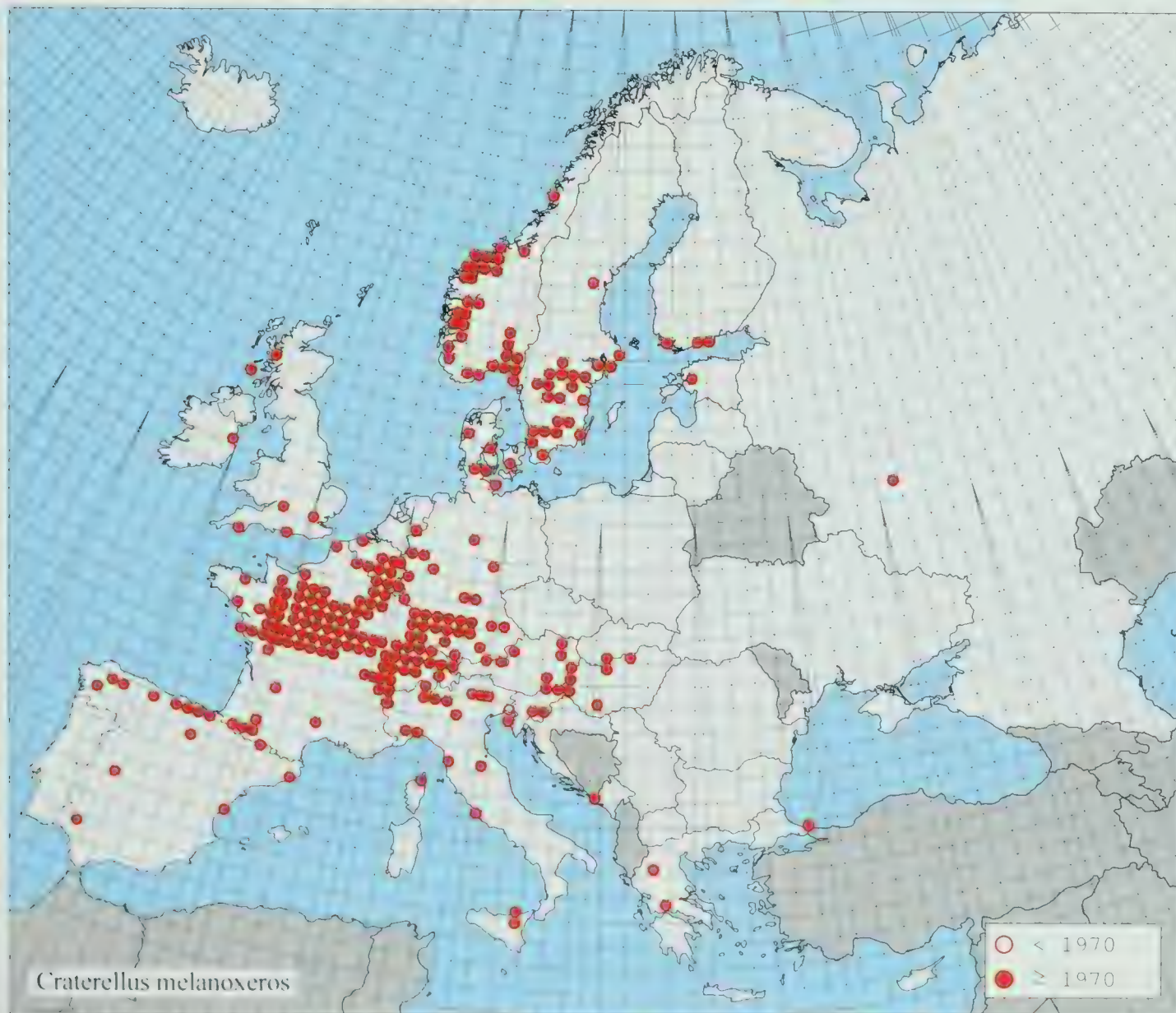
Global distribution: limited to Europe.

Bibliography: Neville & Alpago-Novello (1998), Watling & Turnbull (1998), Fraiture & Walley (2005), Siller et al. (2005), van der Vegte (2010).



Craterellus melanoxeros

Photo Yves Deneyet



Distribution in Europe: The species mainly occurs in the lowlands, occasionally also in mountainous regions (in France and Italy also above 1200 m).

The distribution is included in the distribution of the three main hosts (*Fagus sylvatica*, *Quercus robur* and *Q. petraea*, see Jalas & Suominen 1976: resp. maps 284, 301 and 299), but it is much smaller.

Areal diagnosis for Europe: Mainly Atl., C-Eur. and Alp.; very rare in Bor., Sarm. (S Finland and Estonia), Therm. and Medit.; absent from Aret. and Step.

Trophism, hosts and substrates

The species is ectomycorrhizal and lives with *Fagus sylvatica* and *Quercus* spp. (only *Q. robur* and *petraea*?), in Sweden and UK also with *Corylus avellana*, in France possibly with *Carpinus*. One observation under spruce (*Picea abies*) in Belgium. Cherubini & Dell'Orbo (1993) also report that the species can be observed under pure spruce stands.

Habitat

Vegetation: The species occurs in deciduous (e.g. together with *Castanea*, *Tilia*) and mixed forests (with *Pinus*). In central Europe it prefers warm sites and it is there moderately



Craterellus melanoxeros

Photo Yves Deneyer

thermophilous. In more northern regions, it inhabits boreo-nemoral oak forests (Estonia, Finland).

Syntaxa of vegetation: FORESTS: *Galio odorati-Fagetum*, *Hordelymo-Fagetum* (both Germany), *Carrici-Fagetum* (Germany, Switzerland), *Carpinion betuli* (France), *Luzulo nemorosae-Fagetum sylvaticae*, *Galio rotundifolii-Fagetum sylvaticae*, *Sorbo torminalis-Fagetum sylvaticae*, *Luzulo-Quercetum* (all Hungary), *Seslerio-Oxytryetum carpinifoliae* (Montenegro).

Natura 2000 habitats: Fennoscandian hemiboreal natural old broad-leaved deciduous forests (*Quercus*, *Tilia*, *Acer*, *Fraxinus* or *Ulmus*) rich in epiphytes (code 9020, Estonia, Finland, Sweden), Fennoscandian herb-rich forests with *Picea abies* (code 9050, Finland), Fennoscandian wooded pastures (code 9070, Sweden), *Luzulo-Fagetum* beech forests (code 9110, Germany, Hungary, Luxembourg, Slovakia, Switzerland), Atlantic acidophilous beech forests with *Ilex* and sometimes also *Taxus* in the shrublayer (code 9120, France), *Isopurulo-Fagetum* beech forests (code 9130, Austria, Denmark, France, Germany, Luxembourg, Slovakia, Switzerland, UK), Medio-European limestone beech forests of the *Cephalanthero-Fagion* (code 9150, Denmark, Germany, Slovakia, Slovenia, Switzerland), Sub-Atlantic and Medio-European oak or oak-hornbeam forests of the *Carpinion betuli* (code 9160, Netherlands, UK), *Galio-Carpinetum* oak-hornbeam forests (code 9170, Austria, France, Slovakia, Slovenia, Switzerland), Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles (code 91A0, UK), *Castanea sativa* woods (code 9260, Bulgaria).

Soil requirements: The fungus colonizes rather dry to damp soils, mainly basic to neutral but e.g. in Hungary also distinctly acid. Soil type: e.g. brown soil above limestone and base-rich silicate bedrocks, marl, in Finland also podzol. Nitrogen content: soils more or less nutrient-poor. Grain size: from silt to clay. Litter layer: thin or absent.

Synanthropy: The fungus is restricted to natural and near-natural forests.

Indicator value: The species avoids nitrogen-rich soils; it is moderately thermophilous in central Europe.

Occurrence of fruitbodies (phenology)

Basidiocarps are mainly produced from summer to autumn (July-November), in UK still in December.

Frequency

Number of currently known sites: About 300, of which nearly 150 in France.

Changes in frequency: In France, a decrease has been noticed for the last 3 decades. In Hungary and UK an increase in the number of sites is reported.

Threats and conservation

Threats: Sites are mainly threatened by silvicultural intensification (e.g. fertilization, clear felling, planting of allochthonous trees) and by nitrogen deposition from air pollution.

Status of conservation: The species is red listed in Austria, Denmark, Finland, France, Germany, Hungary, Iberian Peninsula (Spain + Portugal), Norway, Sweden and Switzerland. It is protected by law in Hungary. See also Dahlberg & Croneborg (2003, 2006).

Gomphus clavatus (Pers.: Fr.) Gray
Basidiomycota, Gomphales, Gomphaceae

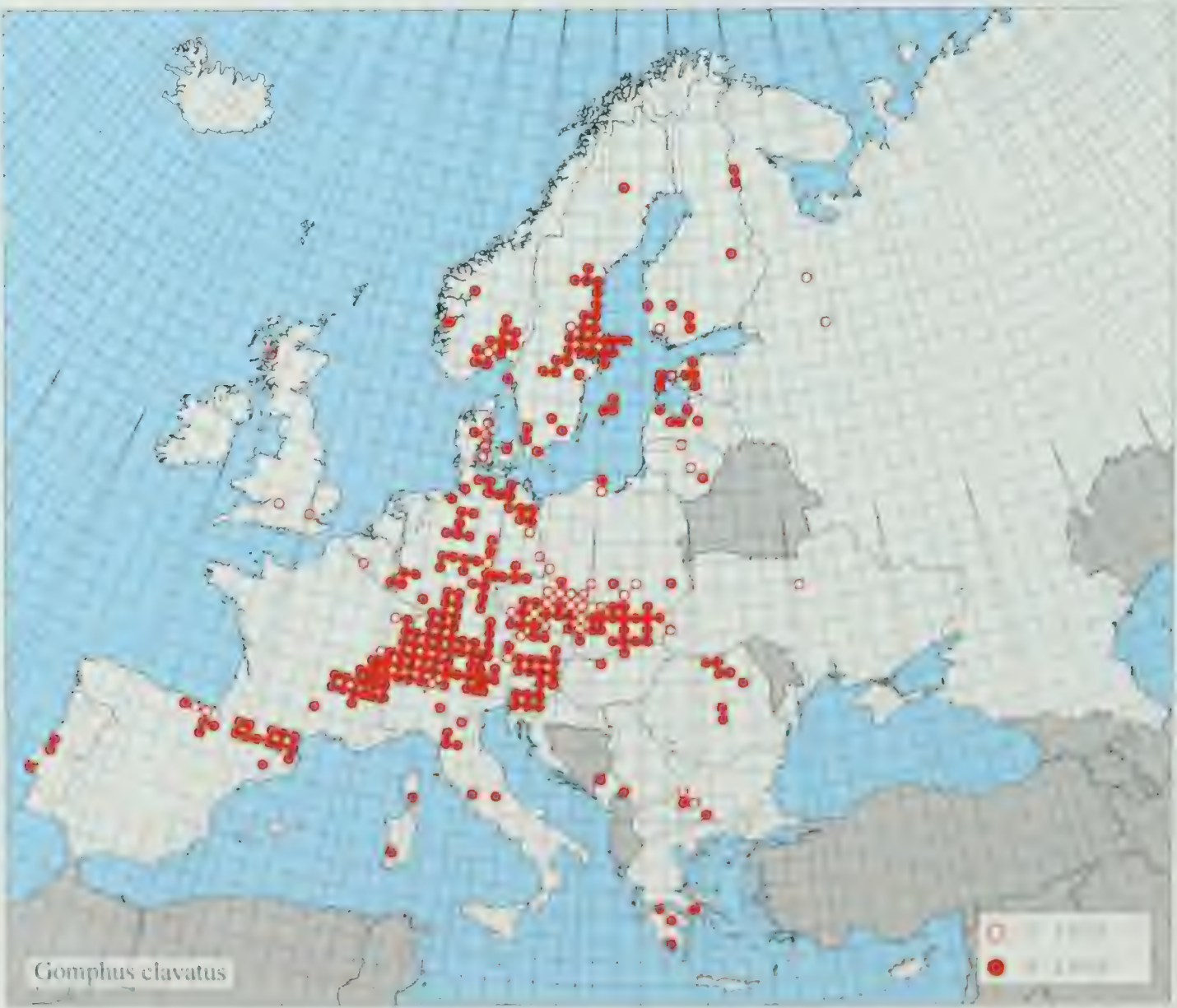
Synonym: *Nevrophyllum clavatum* (Pers.: Fr.) Pat. & Doass.
Excluded: *Gomphus clavatus* var. *parvisporus* Corner [= *G. brunneus* (Heinem.) Corner].

Brief description

An easily recognizable species, with club-shaped to cantharelloid fruitbodies, a veined hymenophore and lilac colours. It is mainly present in Central-European and Alpine domains. It forms ectomycorrhizae with both coniferous and broadleaved trees, in different kinds of forests except those which are strongly influenced by man. The species is mainly threatened by the intensification of forest management (e.g. fertilization, clear felling) and by soil acidification and eutrophication due to air pollution.

Geography

Global distribution: Europe, Asia (Siberia, Georgia, Turkey, Pakistan, Nepal, Kashmir, Korea, China [sub *Cantharellus clavatus*], Japan), North America (USA, Canada, Mexico), South America (Guatemala).





Gomphus clavatus

Photo Yves Deneyer

Bibliography: Corner (1966), Petersen (1972), Lange (1974), Watling & Abraham (1992), Kluzák (1994), Teng (1996), Bessette et al. (1997), Doğan et al. (2005), Fraiture & Walley (2005), Siller et al. (2005), Han et al. (2006), Dörfelt & Bresinsky (2008), Giri & Rana (2008), Sesli & Denchev (2008), Alexov et al. (2012), Flores Arzú et al. (2012), Gvritishvili et al. (2012).

Distribution in Europe: In western, eastern and northern Europe, the species occurs in the lowlands, but in central and southern Europe it grows mainly in mountainous regions (e.g. in Romania and Spain above 1200 m, in Bulgaria up to 1600 m).

Areal diagnosis for Europe: Mainly C-Eur. and Alp.; also Bor., Sarm. (west), Atl., Therm. and Medit.; absent from Arct. and Step.

Trophism, hosts and substrates

The fungus is ectomycorrhizal and lives in symbiosis with coniferous trees: *Abies alba*, *A. cephalonica* (Pantidou 1980), *Picea abies* (Agerer et al. 1998), *Pinus sylvestris* (e.g. Sweden), *P. pinaster* (Portugal, Spain), *P. pinea*? (Portugal), also with *Fagus sylvatica* and sometimes with other deciduous trees (*Quercus robur* in Lithuania, *Q. ilex* in Spain and *Quercus* and *Carpinus* in Czech Republic). It has been observed that the presence of the fungus was related to volume of coarse woody debris (Giachini 2004).

Habitat

Vegetation: The fungus inhabits different kinds of natural and near natural forests where its symbiosis partners are present. Reports exist for beech forests, fir-beech forests, spruce forests, spruce-fir forests, alvar spruce forests of the *Calamagrostis arundinacea* type (Estonia), springy spruce forests with grasses and herbs (Finland), pine forests, mountain co-

niferous forests (*Abies*, *Picea*, *Larix* in Italy), lichen-rich and subalpine forests (e.g. *Picea* in Montenegro and Serbia) and mixed forests. The fungus is also reported from coastal pine dunes in Portugal, and from Mediterranean pine forests in Spain. See also Dörfelt & Bresinsky (2008). According to Lange (1974), the species prefers shady coniferous forests with stony and mossy ground and the findings often consist of groups or fascicles of basidiocarps.

Syntaxa of vegetation: FORISTS: *Fagetum carpaticum* (= *Dentario glandulosae-Fagetum*, Poland), *Querceto-Piceetum* (Lithuania), *Querceto-Pinetum* (Lithuania, Russia), *Abieti-Fagetum* (Bulgaria, Germany, Russia [Caucasus], Slovakia, Switzerland), *Vaccinio-Piceion* (Bulgaria, Germany, Lithuania, Russia, Slovakia, Switzerland), *Fagion sylvaticae* (Bulgaria, France, Switzerland), *Eu-Fagenion*, *Scillo lilio-hyacinthi-Fagenion* (both France), *Carici-Fagetum*, *Hordelymo-Fagetum* (both Germany), *Abieti-Piceion* (Switzerland), *Luzulo nemorosae-Fagetum sylvaticae* (Hungary), *Soldanello majori-Piceetum* (Romania), *Piceetum excelsae croaticum* (Montenegro).

Natura 2000 habitats: Wooded dunes with *Pinus pinea* and/or *Pinus pinaster* (code 2270, Portugal), Western Taïga (code 9010, Estonia, Finland, Latvia, Lithuania, Sweden), Fennoscandian herb-rich forests with *Picea abies* (code 9050, Estonia, Finland, Lithuania, Sweden), *Luzulo-Fagetum* beech forests (code 9110, Czech Republic, Denmark, Hungary, Luxembourg, Slovakia, Spain), *Asperulo-Fagetum* beech forests (code 9130, Austria, Denmark, France, Germany, Poland, Slovakia, UK), Medio-European subalpine beech woods with *Acer* and *Rumex arifolius* (code 9140, Switzerland), Medio-European limestone beech forests of the *Cephalanthero-Fagion* (code 9150, Bulgaria, Czech Republic, Denmark, Germany, Slovakia, Slovenia, Sweden), *Quercus ilex* and *Quercus rotundifolia* forests (code 9340, Spain), Acidophilous *Picea* forests of the mountain to alpine levels (*Vaccinio-Piceetea*) (code 9410, Bulgaria, Germany, Poland, Romania, Slovakia, Slovenia, Switzerland), Mediterranean pine forests with endemic Mesogean pines (code 9540, Spain).

Soil requirements: The species mainly occurs on distinctly basic soils (but often superficially acidified by litter decomposition), seldom also on strongly acid soils. Soil types: brown soil, calcareous sand and clay, marl, rendzina, podzol (Portugal). Geologic substrate: often limestone (e.g. Slovakia), but also mineral-rich silicate bedrocks as granite and crystalline schist (e.g. Bulgaria), pleistocenian sand (Portugal). Nitrogen content: low. Grain size and litter layer: no clear preferences could be revealed (e.g. in Finland mull soils with thick litter layer were recorded). Kotiranta et al. (2009) say « On calcareous soil in moist habitats ».

Synanthropy: The species avoids habitats strongly influenced by man.

Indicator value: The fungus indicates natural and near-natural forests and, in southern and central Europe, it prefers mountainous regions. Parmasto (2001b) lists it among the fungi indicator of primeval and old-growth forests deserving protection.

Occurrence of fruitbodies (phenology)

Basidiocarps are mainly produced from early summer to late autumn (June-November).

Frequency

Number of currently known sites: About 500, among which nearly 50 percent are located in France.

Changes in frequency: There is no record from Lithuania after 1974 and from UK after 1927. In Austria, Denmark, Germany, Hungary, Lithuania, Poland, Slovenia and Sweden a decrease has been noticed for the last 2-6 decades. In Estonia, Finland, France, Russia and Slovakia no changes of frequency have been noticed. In Latvia an increase in the number of sites is reported. See also Kluzák (1994).

Threats and conservation

Threats: Sites are mainly threatened by silvicultural intensification (e.g. fertilization,

clear-felling). Also acidification and eutrophication by immissions are considered as a severe threat.

Status of conservation: The species is red listed in Austria, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Iberian Peninsula (Spain + Portugal), Latvia, Lithuania, Luxembourg, Montenegro, Norway, Poland, Romania, Russia (regional red list), Serbia, Slovakia, Sweden and UK. It is protected by law in Germany, Hungary, Lithuania, Slovakia and Slovenia. The species is included in the IUCN *Global Fungal Red List Initiative* (see their web-site). See also Dahlberg & Croneborg (2003, 2006) and Aronsson (2006).

Faerberia carbonaria (Alb. & Schwein.) Pouzar

Basidiomycota, Polyporales, Polyporaceae

Synonyms: *Geopetalum carbonarium* (Alb. & Schwein.) Pat., *Cantharellus carbonarius* (Alb. & Schwein.) Fr., *Cantharellus leucophaeus* (Pers.) Nouel

Note: The epithet *carbonarius* is sanctioned by Fries (1821, *Syst. mycol.* 1: 318) at the infraspecific level only: *Cantharellus umbonatus* β . *M. carbonarius*.

Brief description

With its cantharelloid habit, its blackish-brown cap, its pale grey brown stem and its growth on fire places, the “firesite funnel” is easy to recognize. It is mostly present in the Atlantic, Central-European and Alpine domains. It lives as a saprotroph on burnt wood. The species is decreasing in some countries since campfires have been banned, because of the fire hazard and the air pollution they generate.

Geography

Global distribution: Europe, Asia (Ural Mountains, Georgia, Turkey, China), Africa (Canary Islands, Morocco, Tunisia, South Africa), North America (USA, Mexico), Oceania (Australia).

Bibliography: Doidge (1950), Malençon & Bertault (1975), Bañares et al. (1986), Migliozi & Coccia (1989), Teng (1996), May & Wood (1997), Estrada-Torres & Cifuentes (1998), Hrouda (2001), Fraiture & Walley (2005), Bresinsky & Dörfelt (2008), Sesli & Denchev (2008), Gvritishvili et al. (2012).



Faerberia carbonaria

Photo Yves Desteyer

Distribution in Europe: The species occurs from the lowlands to mountain regions (in Italy also above 1200 m).

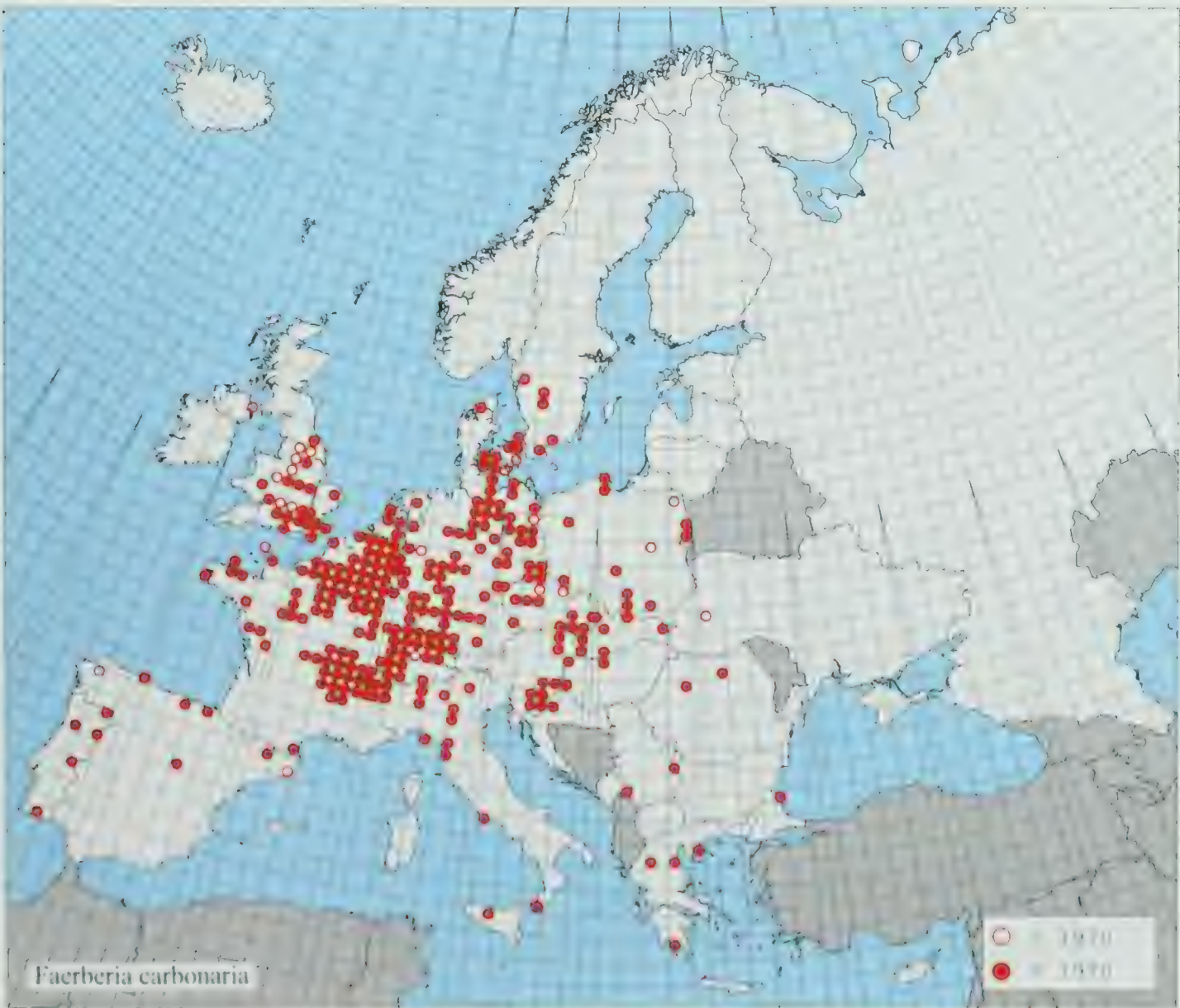
Areal diagnosis for Europe: Mainly Atl., C-Eur. and Alp.; also present in Therm. and Med-it.; very rare in Sarm. (west); absent from Arct., Bor. and Step.

Trophism, hosts and substrates

The fungus is a carbonicolous species and lives as a saprotroph on old fire sites, especially those made by loggers after clear cutting. The species is decaying burnt wood of coniferous (e.g. Czech Republic, Poland) as well as of deciduous trees (records e.g. from Slovenia, Sweden, UK). In Serbia the species was found around a burnt beech stump.

Habitat

Vegetation: The fungus colonizes preferentially old firesites often more or less covered by mosses (e.g. *Barbula* spp., *Funaria hygrometrica*, *Marchantia polymorpha*) but still free from vascular plants. The firesites can be located inside forests as well as outside. The following vegetation types are reported: deciduous forests, e.g. of *Castanea*, *Quercus* spp. (Italy), *Castanea* (Hungary) and *Fagus* (Serbia, Belgium), sclerophyllous forests of



Quercus ilex and *Q. suber* (Italy) and coniferous forests, e.g. of *Picea* (Germany), *Pinus* (Poland), *Pinus nigra* (Greece, fide Zervakis et al. 2002) and *Pinus halepensis* (Spain, fide Garcia-Manjon & Moreno 1980). Suitable biotopes are also the sides of forest roads and railroads, gardens and cemeteries.

Syntaxa of vegetation: The species is bound to fire places, and can appear in many kinds of forests. Fire places are often colonized by an association of bryophytes (*Funarietum hygrometricae*). *Faerberia carbonaria* has been observed in that association in Germany but it is probable that it grows in the same association in many European countries.

Natura 2000 habitats: The species is bound to fire places and no particular Natura 2000 habitat can be cited.

Soil requirements: The characters of the soil below the layer of burnt wood and ash have probably no significance for the occurrence of the fungus. There are observations e.g. on granite, limestone (Spain), sand (Netherlands), on acid and basic soils. The reports reveal a colonization of dry as well as of rather wet places. Nitrogen content: moderately high.

Synanthropy: The species is indifferent regarding synanthropy. It appears in natural habitats as coniferous forests (lightning-ignited fires) as well as in very anthropogenic habitats such as cemeteries (Germany).

Indicator value: The species is a very good indicator for old fire sites.

Occurrence of fruitbodies (phenology)

In regions with cold winters, basidiocarps are produced from early summer till late autumn (May-November). In regions with mild winters (e.g. southern France, Italy) fruitbodies can be found almost all the year round.

Frequency

Number of currently known sites: About 300.

Changes in frequency: In Romania, there is no record after 1975. In Denmark and France a decrease has been noticed for the last 2 decades, in the Netherlands a slight decrease is reported since 1960. In Czech Republic and Poland no changes of frequency were announced.

Threats and conservation

Threats: In a few countries, e.g. Belgium, Denmark, France, Germany, Netherlands (Veerkamp 1998), there is a decrease of the species because fireplaces are less frequent (regional burning is prohibited due to fire hazard and air pollution).

Status of conservation: The species is red listed in Austria, Belgium (regional red list), Czech Republic, Denmark, France, Netherlands and Poland (regional red list). It is protected by law in Slovenia.

Hapalopilus croceus (Pers.: Fr.) Donk

Basidiomycota, Polyporales, Polyporaceae

Synonym: *Aurantioporus croceus* (Pers.: Fr.) Murrill

Brief description

A polypore species, with large, soft, annual fruitbodies of orange colour. It is mostly present in the Central-European and Sarmatic domains. It lives first as a weak parasite, then as a lignicolous saprotroph. It almost always grows on old oaks (*Quercus*), in thermophilous deciduous forests but also on isolated trees, in parks or on roadsides. It is mainly threatened by the felling of old oak trees and by silvicultural intensification in general.

Geography

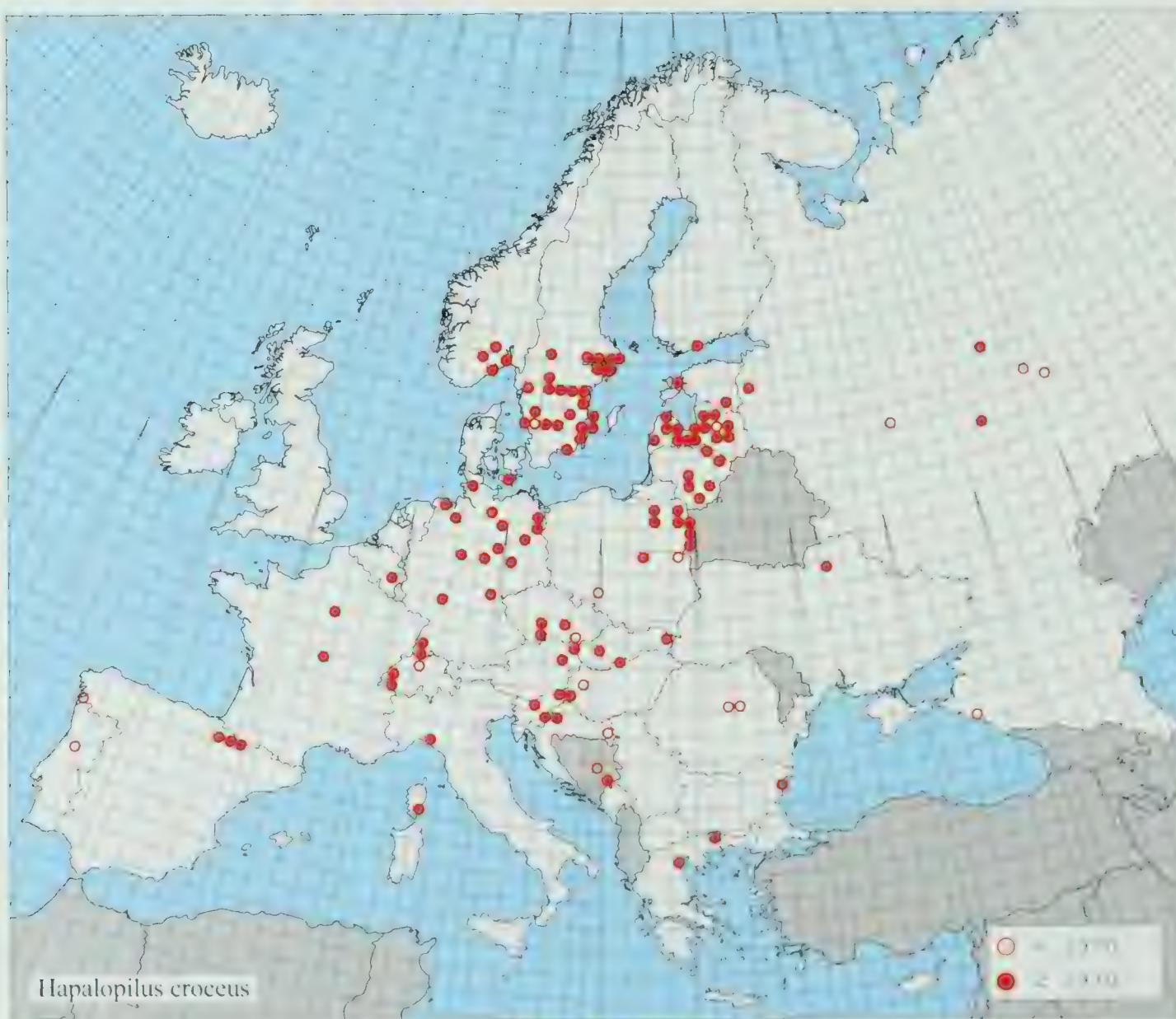
Global distribution: Europe, Asia (Siberia, Armenia, Georgia, China, Japan, Indonesia), North America (USA, Canada).

Bibliography: Bondartsev (1953), Černý (1966), Buchwald (1978), Gilbertson & Ryvarden (1986), Zhao & Zhang (1992), Teng (1996), Núñez & Ryvarden (2001), Bujakiewicz (2002), Boulet (2003), Fraiture & Walley (2005), Niemelä (2005), Piątek & Wołkowiecki (2005), Bresinsky & Dörfelt (2008), Dai (2012), Gvritishvili et al. (2012).



Hapalopilus croceus

Photo Jean-Pierre Vidonne



Distribution in Europe: The species mainly occurs in the lowlands, only exceptionally in mountainous regions (in Greece and Spain also above 1200 m).

The map presented by Ryvarden & Gilbertson (1993) includes UK in the distribution of the species but we did not receive any confirmation of its presence in that country; the mention probably comes from a doubtful interpretation of Bolton's *Boletus heteroclitus* (Legon & Henrici 2005). There is also a doubtful record in the BMS database: on *Betula*, Scotland, West Sutherland, 2004. The points in Bosnia-Herzegovina have been added after Tortić (1984): "Koševo near Sarajevo" and "Sutjeska National park, Tjentište", "In the same National park as *Amylocystis lapponica*; the locality was however lower by 400 m and situated in a warmer part of the park". Besides localities indicated on the map presented here, the species is also present in Belarus (Maslovsky 2004). This distribution is included in the distribution area of one of the main hosts: *Quercus robur* (see Jalas & Suominen 1976: map 301).

Areal diagnosis for Europe: Mainly Sarm. (esp. in the boreo-nemoral zone) and C-Eur. (id.); also in Alp. and Therm.; very rare in Bor. (south), Atl. and Medit.; absent from Arct. and Step.

Trophism, hosts and substrates

The species is lignicolous and probably lives first as a weak parasite and then as a saprotroph. It inhabits the trunk or thick branches of old living trees, causing a white rot, and survives many years after the death of the tree, on standing and lying trunks and on stumps. It is almost always oaks which are colonized: *Quercus cerris* (Bulgaria), *petraea*, *robur*, *rubra* (Germany), *Quercus* sp. (Poland). Melo et al. (2007) also cite *Quercus rotundifolia* as a host. The species has rarely been found on other host trees: *Castanea sativa* (e.g. Hungary, Italy), *Fagus sylvatica* (France, Greece) and *Picea abies* (Greece, Romania). Gilbertson & Ryvarden (1986) cite a collection on *Robinia* in Europe (without other precision), but Ryvarden & Gilbertson (1993) and Ryvarden & Melo (2014) cite only *Quercus* and *Castanea*. Associated fungi are e.g. *Fistulina hepatica*, *Ganoderma resinaceum*, *Inonotus dryadeus*, *Laetiporus sulphureus* and *Xylobolus frustulatus*.

Habitat

Vegetation: The species mainly occurs in thermophilous deciduous forests with old oaks, e.g. in alluvial forests, at warm forest edges, but also near dams or ponds (Czech Republic), in mixed forests (Romania), wooded meadows with oaks (Estonia, Latvia), road sides and parks (e.g. Finland, Latvia, Slovenia). In Greece even natural beech forests, in Greece and Romania natural spruce forests were colonized.

Syntaxa of vegetation: FORESTS: *Genisto tinctoriae-Quercenion robori-petraeae*, *Ulmenion minoris*, *Quercetum minoris* (all Germany), *Quercetalia roboris* (France), *Carpinion betuli* (France, Germany, Hungary, Poland), *Tilio-Quercetum* (Lithuania), *Tilio cordatae-Carpinetum betuli* (Poland), *Quercetum cerridis* (Bulgaria, Hungary), *Hieracio rotundati-Piceetum* (Romania).

Natura 2000 habitats: Fennoscandian wooded meadows (code 6530, Latvia), Fennoscandian hemiboreal natural old broad-leaved deciduous forests (*Quercus*, *Tilia*, *Acer*, *Fraxinus* or *Ulmus*) rich in epiphytes (code 9020, Estonia, Latvia, Lithuania, Sweden), Fennoscandian wooded pastures (code 9070, Sweden), *Luzulo-Fagetum* beech forests (code 9110, France), Atlantic acidophilous beech forests with *Ilex* and sometimes also *Taxus* in the shrublayer (code 9120, France), *Asperulo-Fagetum* beech forests (code 9130, France), Medio-European subalpine beech woods with *Acer* and *Rumex arifolius* (code 9140, Romania), Sub-Atlantic and Medio-European oak or oak-hornbeam forests of the *Carpinion betuli* (code 9160, Austria, Denmark, France, Germany, Poland, Sweden, Switzerland), *Galio-Carpinetum* oak-hornbeam forests (code 9170, France, Poland), *Tilio-Acerion* forests of slopes, screes and ravines (code 9180, Latvia), Old acidophilous oak woods with *Quercus robur* on sandy plains (code 9190, France, Slovenia), Alluvial forests with *Alnus* and *Fraxinus* (code 91F0, Czech Republic, Latvia), Riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *Ulmus minor*, *Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*) (code 91F0, Croatia, Czech Republic, Germany, Latvia), Pannonic woods with *Quercus petraea* and *Carpinus betulus* (code 91G0, Croatia), Pannonian woods with *Quercus pubescens* (code 91H0, Slovakia), Pannonian-Balkan turkey oak - sessile oak forests (code 91M0, Bulgaria, Hungary, Slovakia), Galicio-Portuguese oak woods with *Quercus robur* and *Quercus pyrenaica* (code 9230, Portugal), *Castanea sativa* woods (code 9260, Italy).

Soil requirements: Since the species is lignicolous, soil characters should be without much relevance. Reported soil types are sand, brown soil, grey soil, vega and limestone.

Synanthropy: The species is mainly restricted to natural and near-natural forests, occasionally it was found in anthropogenic biotopes (e.g. parks).

Indicator value: The species is a rather good indicator of thermophilous forests and woods with old oaks. Parmasto & Parmasto (1997) cite the species among the indicator species of old forests, not much modified by man, in Estonia.

Occurrence of fruitbodies (phenology)

Basidiocarps are mainly produced from early summer till late autumn (May-November), in Portugal still in December.

Frequency

Number of currently known sites: About 100 (more than 50 % of which in Latvia and Sweden).

Changes in frequency: There is no record for Romania after 1937. In France, Germany and Sweden a decrease has been noticed for the last decades. In Czech Republic, Estonia and Greece no changes of frequency were announced. In Poland an increase has been observed over a period of 30 years.

Threats and conservation

Threats: It is mainly threatened by felling of old oak trees and by silvicultural intensification in general. The danger of such felling is even greater as the species usually grows on a single tree in its growthplaces (Iršėnaitė et al. 2013).

Status of conservation: The species is red listed in Austria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Latvia, Lithuania, Norway, Poland, Serbia, Slovakia and Sweden. It is protected by law in Croatia, Estonia, Latvia, Lithuania and Slovakia. The species is included in the IUCN *Global Fungal Red List Initiative* (see their web-site). See also Dahlberg & Croneborg (2003, 2006).

Haploporus odorus (Sommerf.: Fr.) Bondartsev & Singer

Basidiomycota, Polyporales, Polyporaceae

Synonyms: *Polyporus odorus* Sommerf.: Fr., **non** *Polyporus odorus* Peck [= *Skeletocutis odora*], *Fomitopsis odoratissima* Bondartsev.

Note: Macroscopically, the species is easily confused with *Trametes suaveolens* (L.: Fr.) Fr., syn.: *Haploporus suaveolens* (L.: Fr.) Donk., but *H. odorus* has a northern distribution, grows almost exclusively on *Salix caprea* and has small ($5.0\text{--}6.5 \times 3.0\text{--}4.5 \mu\text{m}$) minutely echinulate spores.

Brief description

A polypore producing thick, perennial fruitbodies, with a pale buff colour and a strong smell of anise. It is typically a species of the boreal taiga, where it grows almost exclusively on goat willows (*Salix caprea*). It is mainly threatened by felling of old willows and by intensification of silvicultural practices.

Geography

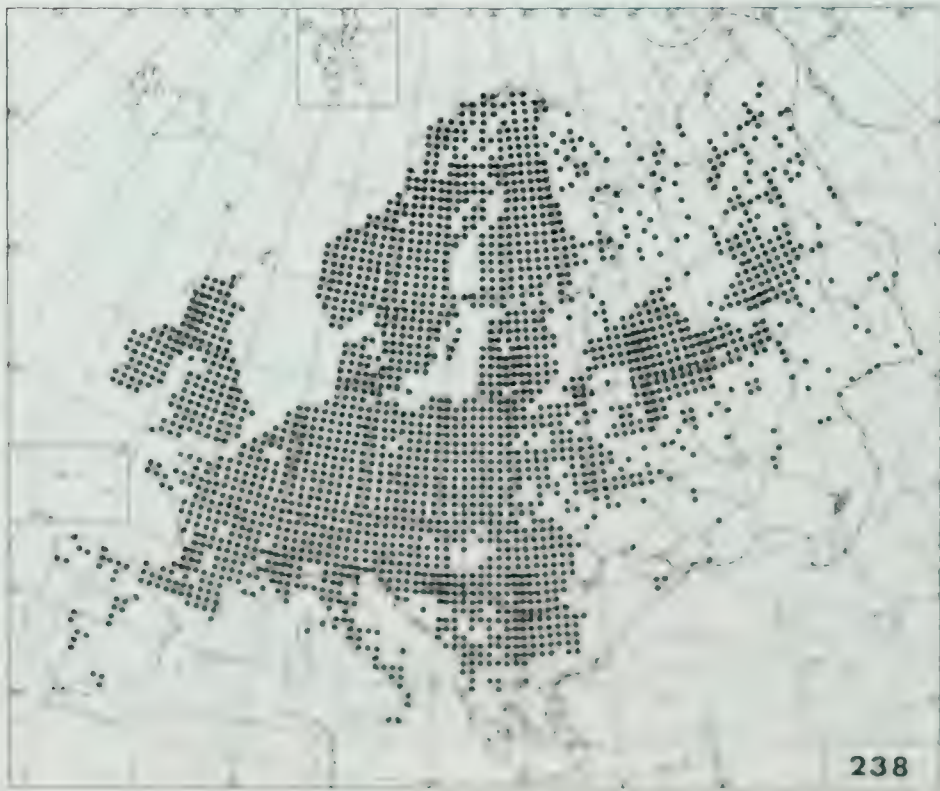
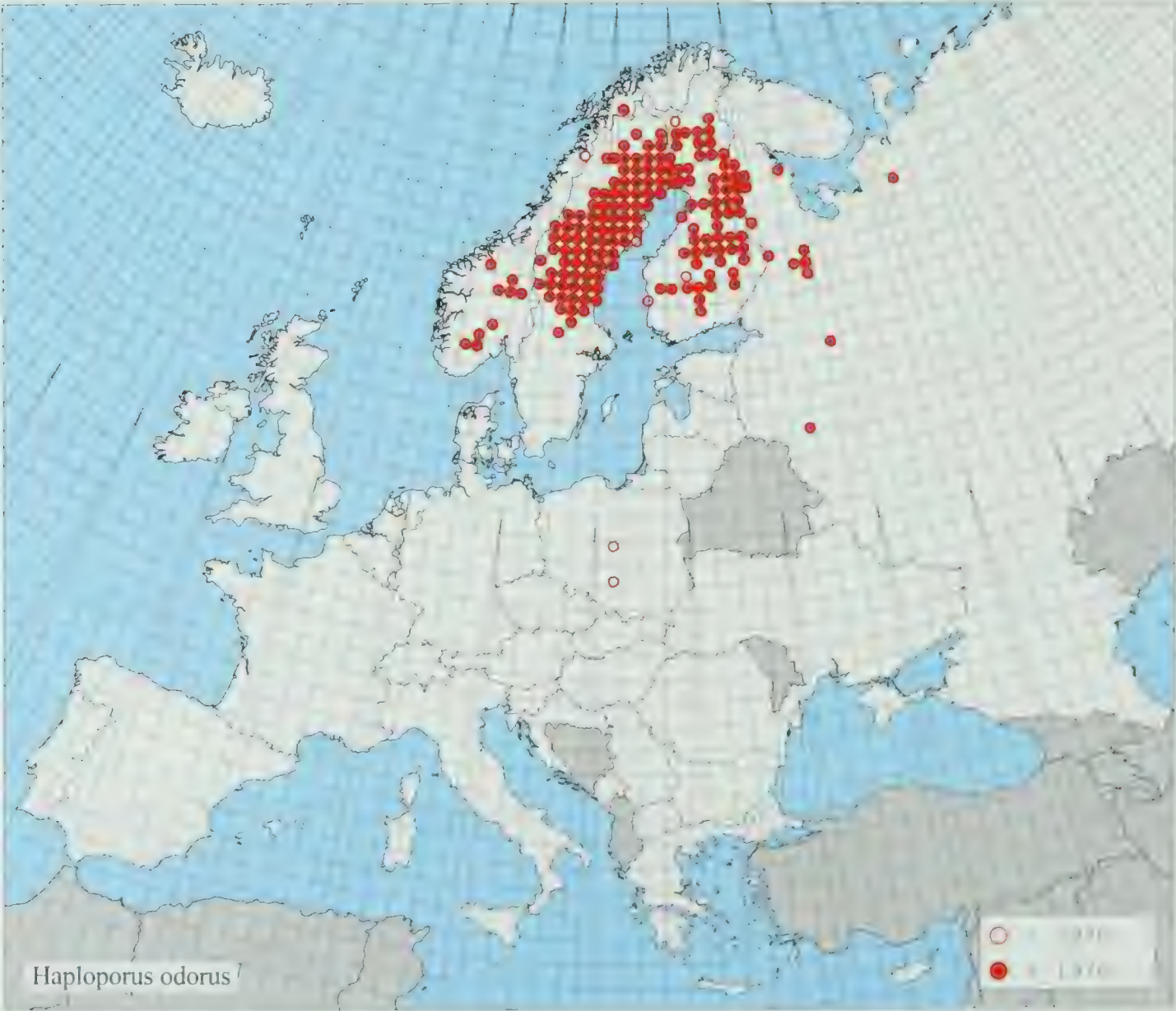
Global distribution: Europe, Asia (Armenia, Siberia, China, Japan), North America (Canada).

Bibliography: Kotiranta & Niemelä (1981), Gilbertson & Ryvarden (1986), Niemelä et al. (2001), Núñez & Ryvarden (2001), Dai (2012).



Haploporus odorus

Photo Heikki Kotiranta



Distribution of *Salix caprea* in Europe. From *Atlas Florae Europaeae* 3 (Jalas & Suominen 1976). Courtesy of the Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo

Distribution in Europe: The species mainly occurs in the lowlands, only exceptionally in mountainous regions (in Finland and Sweden above 500 m, in Russia in the mountains of Kabardino-Balkarie).

Areal diagnosis for Europe: Almost exclusively Bor.; one locality in Sarm. (Russia) and possibly in Arct., two ancient mentions in C-Eur. (Poland); absent from the other domains.

Trophism, hosts and substrates

It is a lignicolous fungus living on old and tall willows. It seems that, in Fennoscandia, it always grows on *Salix caprea*, with the exception of a single collection on *Prunus cerasus* (Niemelä 1971, Ryvar den & Gilbertson 1993, Granmo 2007, Kotiranta et al. 2009, Ryvar den & Melo 2014). Accordingly, the fungus is extremely specialized and stenoecious.

Habitat

Vegetation: The species is restricted to boreal and (rarely) mountainous more or less wet habitats with old willows and is typically bound with taiga (Ryvar den 1993a, 1993b, Ryvar den & Melo 2014). Suitable sites are e.g. moist depressions in spruce dominated old-growth forests and undisturbed old stands along brooks.

Syntaxa of vegetation: FORESTS: *Melico nutantis-Piceetum*, *Salici pentandrae-Betuletum pubescentis* (both Rus-sia).

Natura 2000 habitats: Western Taïga (code 9010, Finland, Sweden), Fennoscandian herb-rich forests with *Picea abies* (code 9050, Finland, Sweden), Bog woodland (code 91D0, Finland).

Soil requirements: Because the species is lignicolous, soil characters should be without much relevance. According to the ecological preferences of *Salix caprea* the soils of the sites should be more or less wet and not too poor in nutrients.



Haploporus odorus
Photos Tom H. Holton

Synanthropy: The species is restricted to natural and near-natural habitats.

Indicator value: The species indicates old stands of tall willows at more or less wet places.

Occurrence of fruitbodies (phenology)

Basidiocarps are perennial and can therefore be found all over the year.

Frequency

Number of currently known sites: About 150 (nearly 90 % of which in Sweden).

Changes in frequency: In Sweden, a decrease has been noticed for the last 3 decades. In Finland no changes of frequency have been observed.

Threats and conservation

Threats: The fungus is mainly threatened by felling of old willows and by silvicultural intensification in general.

Status of conservation: The species is red listed in Finland, Norway, Russia (regional red lists), Sweden. It is protected by law in Sweden. See also Dahlberg & Croneborg (2003, 2006).

Note: The Indigenous Peoples of the northern American plains used *Haploporus odoratus* to ornament sacred robes, human scalp necklaces and other cultural properties. The fungus was also a component of medicine bundles and used for protection against illness (Blanchette 1997).

Polyporus rhizophilus Pat.

Basidiomycota, Polyporales, Polyporaceae

Synonym: *Polyporellus rhizophilus* (Pat.) Pilát

Note: The species is often cited as „*Polyporus rhizophilus* (Pat.) Sacc., *Syll.* **XI**: 82 (1895); basionym: *Melanopus rhizophilus* Pat., *J. Bot.* **8**: 219 (1894)“. However, Patouillard published his new species as *Polyporus rhizophilus* and Saccardo cites „*Polyporus rhizophilus* Pat.“, without making any new combination. The genus *Melanopus* is cited in none of these two references.

Brief description

A distinctive polypore, producing small annual sporophores, with an ivory to greyish cap and a central brown or blackish stipe. It is a rare species which is absent from the northern half of Europe. It colonizes the basal parts of many perennial grasses (*Poaceae*), especially *Stipa* species, in dry and warm grassy sites, mainly steppes and steppe-like grasslands. It is mostly threatened by intensification or cessation of grassland management, eutrophication and afforestation.

Geography

Global distribution: Europe, Asia (Turkey, central Asia: e.g. Kazakhstan, Mongolia, China), Africa (Morocco, Algeria, Tunisia), South America (Argentina).



Polyporus rhizophilus

Photo Mikael Jeppson



The species is absent from North America but the North American species *Polyporus cryptopus* is very similar, if not synonym (Ryvarden & Gilbertson 1994).

Bibliography: Patouillard (1894), Hruby (1931), Rauschert (1962), Šebek (1962), Toma & Vitaliano (1972), Dörfelt (1974), Kubát (1975), Calonge et al. (1976), Salata (1977), Telleria (1980), Zhao & Zhang (1992), Teng (1996), da Silveira & Wright (2005), Doğan et al. (2005), Kreisel (2006), Sesli & Denchev (2008), Łuszczynski & Łuszczynska (2010), Dai (2012).

Distribution in Europe: The fungus grows almost exclusively in the lowlands (up to 600 m in Switzerland).

Areal diagnosis for Europe: Southern half of Europe; mainly C-Eur. (south), Therm. (a.o. Hungarian steppe: "puszta"), Medit. and Step.; also in Sarm. (woody steppe) and Alp.; absent from Arct., Bor. and Atl.

Trophism, hosts and substrates

The fungus belongs to the group of so-called rhizophilic *Polyporus* species which presumably mortally living plant tissues and decay them after death (perthobiotic mode of nutrition). It colonizes the basal parts of perennial Poaceae, leaf sheaths, culm bases, rhizomes and roots. Most often the fungus was found on feather grasses (*Stipa* spp.), but also on *Br-*

thriochloa ischaemum, *Brachypodium pinnatum* (Germany), *Bromus riparius* (Ukraine), *Cynodon dactylon*, *Digitaria* spp., *Elymus* spp., e.g. *Elymus hispidus* (Czech Republic) and *Festuca* spp. Šebek (1962) cites numerous collections from Czechoslovakia, with these additional hosts: *Andropogon* sp., *Chrysopogon gryllus*, *Elymus repens* × *hispidus*, *F. ovina*, *Festuca rubra*, *F. valesiaca*, *Koeleria macrantha*, *Stipa capillata* (the most frequent host) and *S. tirsia*. Other hosts are cited by various authors: *Poa bulbosa* (Tellería 1980), *Agropyron* and *Lasiagrostis* (Toma & Vitalariu 1972), *Calamagrostis* and *Poa* (Łuszczynski & Łuszczynska 2010), *Stipa joannis*, *S. pulcherrima* (Kubát 1975). It is likely that still some other genera and species of Poaceae can be colonized.

Habitat

Vegetation: The species inhabits dry and warm grassy sites, mainly steppes and steppe-like grasslands. The fungus also occurs in grassy open woodlands, e.g. *Quercus ilex* forests (Spain), shelter belts in steppe reserves (Ukraine); seldom it was found in arboreta and parks (Poland, Ukraine). The map presented by Šebek (1962) shows that all the 11 localities of the species in Czechoslovakia are situated in the xerothermic (pannonic) zone of the country. After Favre & Ruhlé (1947), the species seems to be more frequent in zones which burned the year before. See also Bondartsev (1953), Rauschert (1962), Stasińska (2008) and Łuszczynski & Łuszczynska (2010).

Syntaxa of vegetation: FORESTS: *Junipero-Populetum albae* (Hungary); GRASSLANDS: *Mesobromion* (Germany), *Festuco valesiaca*-*Stipetum capillatae* (Germany, Poland, Romania, Russia), *Festuco-Brometea*, *Sisymbrio-Stipetum capillatae* (both Poland), *Festucetalia valesiaca* (Czech Republic), *Festucetum vaginatae* (Hungary).

Natura 2000 habitats: Pannonic inland dunes (code 2340, Austria), Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (code 6210, Bulgaria, Germany, Poland, Slovakia), Pannonic sand steppes (code 6260, Hungary, Slovakia), Ponto-Sarmatic steppes (code 62C0, Ukraine).

Soil requirements: Inhabited soils are always distinctly dry and mostly sandy, but from Poland also clayey soil is reported. Soil types: e.g. brown soil (Bulgaria), grey soil (Romania), loess (Germany). PH-value: from acid to basic (e.g. above limestone). Nitrogen content: apparently low to moderate. Litter layer: absent or thin.

Synanthropy: The species mainly occurs in natural and semi-natural xerothermic grasslands, seldom in open woodlands with planted trees (arboreta and gardens). Łuszczynski & Łuszczynska (2010) cite an observation at an anthropogenic locality in which grasses connected with xerothermic habitats are absent. After these authors, it may suggest that other factors are playing a role, such as global warming and climate continentalisation in some regions.

Indicator value: The fungus is thermophilous and characteristic for dry and warm grassy habitats.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from spring till autumn (April–November).

Frequency

Number of currently known sites: About 50, but the species is certainly widespread in the steppe and forest-steppe zones.

Changes in frequency: In Germany and Hungary a decrease is reported for the last 3-5 decades. In France no changes have been noticed. In Poland an increase in the number of sites is reported.

Threats and conservation

Threats: Sites are mainly threatened by intensification or cessation of grassland management, eutrophication and afforestation. Łuszczyński & Łuszczyńska (2010) also cite excessive burning of grassy xerothermic communities as the cause of displacement and disappearance of grasses on which the fungus grows.

Status of conservation: The species is red listed in Austria, Bulgaria, Czech Republic, France, Germany, Poland, Russia (regional red lists), Slovakia and Switzerland.

Skeletocutis odora (Sacc.) Ginns

Basidiomycota, Polyporales, Polyporaceae

Synonyms: *Polyporus odoratus* Peck (see note), *Poria odora* Sacc. (see note), *Antrodia odora* (Sacc.) Gilb. & Ryvarden, *Skeletocutis tschulymica* (Pilát) Jean Keller

Note: In the *Sylloge fungorum* (6: 294), Saccardo (1888) writes “**Poria odora** Peck 38 Rep. St. Mus. pag. 92”. In fact, Peck never published that name and the text of Saccardo should be understood as “**Poria odora** Sacc., nom. nov. to replace *Polyporus odoratus* Peck 38 Rep. St. Mus. pag. 92 (1885) **non** *Polyporus odoratus* Sommerf.: Fr. (1826) [= *Haploporus odoratus*]”.

Brief description

A polypore producing fairly large resupinate annual basidiocarps, with a soft to gelatinous texture, a whitish to pale beige colour and a characteristic sweetish smell. It is mainly present in the Boreal domain and in the northernmost parts of the Central European and Sarmatic domains. It lives as a lignicolous saprotroph on large often decorticated fallen trunks, mostly of spruce (*Picea abies*). The species is a good indicator for virgin coniferous forests and mixed forests with conifers. It is threatened by the regression of this kind of habitat.

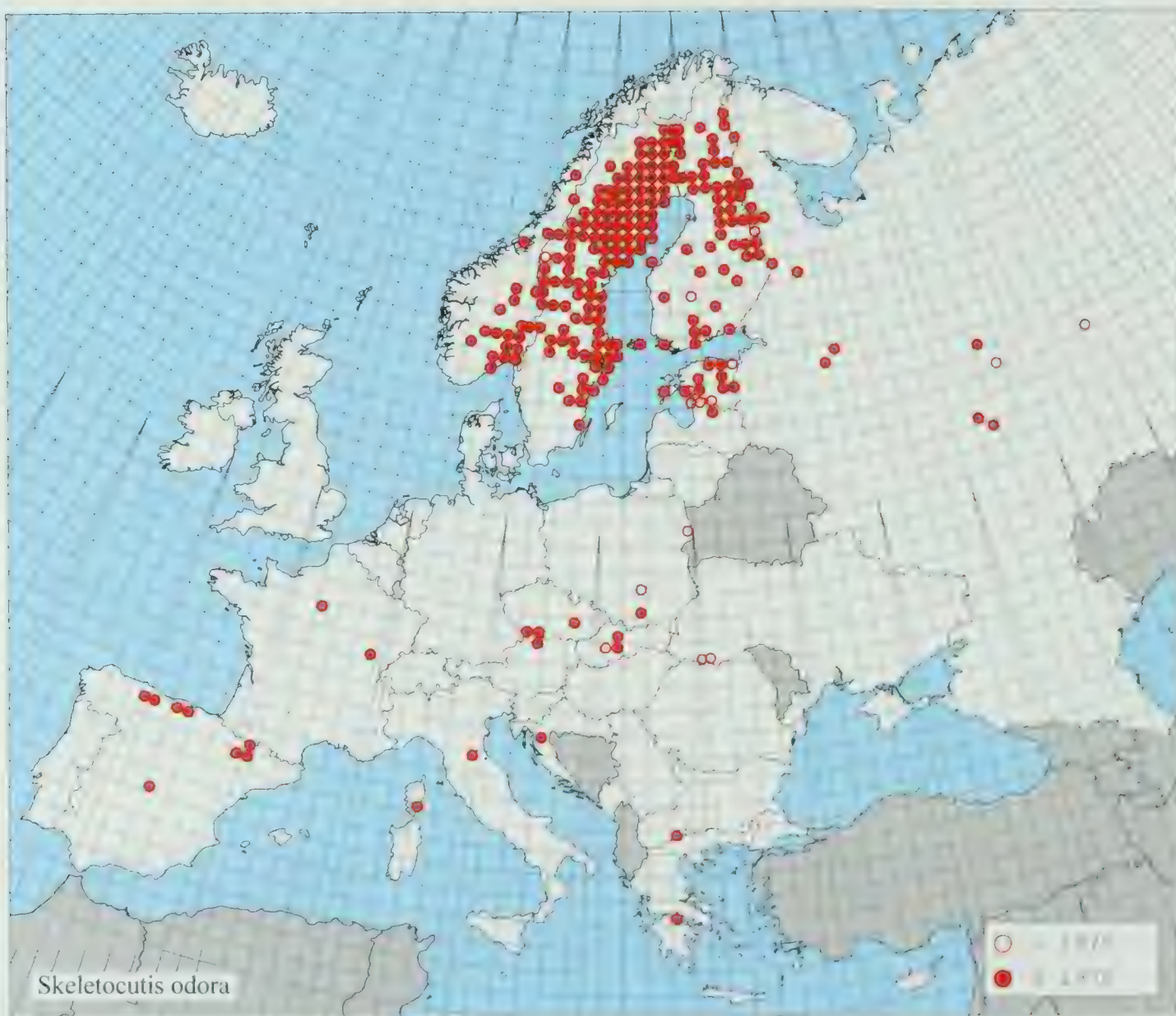
Geography

Global distribution: Circumboreal species, observed in Europe, Asia (Armenia, Siberia, India, China, Japan), North America (USA, Canada).



Skeletocutis odora

Photo Jacob Heilmann-Clausen



Bibliography: Gilbertson & Ryvarden (1986), Niemelä et al. (2001), Núñez & Ryvarden (2001), Piątek (2005d), Dai (2012).

Distribution in Europe: The species occurs in the lowlands as well as in mountainous regions (in Macedonia, Spain and Ukraine above 1200 m).

After Niemelä (1998), the distribution extends to the last spruce stands of the northern timberline. Besides localities indicated on the map, the species is also present in Belarus (Maslovsky 2004) and, according to Piątek (2005d), could be present in Great Britain and Romania. However, the mention from Great Britain is based on a misidentified specimen of *Skeletocutis kuehneri* (Legon & Henrici 2005: 403).

Areal diagnosis for Europe: Typically Bor.; also Sarm. and C-Eur. (both Boreo-nemoral part) and scattered observations in Arct., Atl., Alp., Therm. and Medit.; absent from Step.

Trophism, hosts and substrates

The species is a lignicolous saprotroph often living on large fallen trunks. Mostly the coarse wood is moderately decayed. In northern Europe and in mountainous regions the fungus mainly occurs on coniferous wood, most often on *Picea abies* but also on *Pinus sylvestris*.

and in some cases on *Abies alba* (Croatia, Poland, Ukraine), in Macedonia even on *Abies borisii-regis*. In France, a preference for deciduous trees is reported: *Quercus* and *Populus* besides *Pinus*; in Finland, Russia and southern Sweden, the fungus has also been observed on *Populus tremula*; in southern Sweden on *Betula* as well. Ryvar den & Gilbertson (1994) and Ryvar den & Melo (2014) mention another Swedish collection, on *Alnus incana*, and Melo et al. (2007) give *Pinus pinaster*, *P. radiata* and *P. sylvestris* as the hosts for Spain. In Finland, the hosts are *Picea* and *Populus* (Kotiranta et al. 2009). In Lapland, the species always grows on *Picea abies*, mainly on fallen but still corticated trunks (Renvall et al. 1991). Hermansson (1997) mentions rare collections on *Pinus sibirica*, in the east of the European part of Russia. A collection on *Fagus sylvatica* has been made in Poland (Piątek 2005d). In Finland the fungus has often been found together with *Amylocystis lapponica*, *Fomitopsis rosea*, *Phellinus ferrugineofuscus*, *Phlebia centrifuga* and *Meruliopsis taxicola* (Renvall et al. 1991).

Habitat

Vegetation: Old-growth spruce forests of the boreal and mountain zone (e.g. Slovakia) are the main habitat of this fungus, but it also occurs in virgin pine (e.g. Sweden) and virgin fir forests (Poland) in the lowlands (see p. 19). Sometimes the fungus was found in forests mixed with coniferous and deciduous trees (e.g. *Abies*, *Picea* and *Fagus* in Croatia). In France it is reported from old deciduous forests. After Niemelä (1998), it favours rich, mesic or moist sites, in the south of Finland old and shady stands of spruce, but in Lapland it is often found also in fairly open hill-top spruce woodlands. After Hermansson (1997) in Russia, pure spruce forest is probably the main habitat of the species, which usually occurs on large decorticated logs in moist places, but it is also found in different mixed forests and in late successions after fire.

Syntaxa of vegetation: FORESTS: *Vaccinio-Piceion*, *Vaccinio-Abietion*, *Tilio-Carpinetum* (all Poland), *Vaccinio myrtilli-Piceetum*, *Oxalido acetosellae-Piceetum* (both Russia), *Vaccinio-Piceetea* (France), *Abieti-Fagetum* (Macedonia).

Natura 2000 habitats: Western Taïga (code 9010, Estonia, Finland, Sweden), Fennoscandian herb-rich forests with *Picea abies* (code 9050, Estonia, Finland, Poland, Sweden), *Asperulo-Fagetum* beech forests (code 9130, Slovakia), *Galio-Carpinetum* oak-hornbeam forests (code 9170, Poland), Holy Cross fir forests (*Abietetum polonicum*) (code 91P0, Poland), Moesian silver fir forests (code 91BA, Croatia), Hellenic beech forests with *Abies borisii-regis* (code 9270, Macedonia), Acidophilous *Picea* forests of the mountain to alpine levels (*Vaccinio-Piceetea*) (code 9410, France).

Soil requirements: Since the species is lignicolous, soil characters should not be of great importance. According to the ecology of the different host trees the range of inhabited soils is wide.

Synanthropy: It is an anthropophobous fungus only found in natural or near-natural forests.

Indicator value: The species is a good indicator for virgin coniferous forests and mixed forests with conifers. Parmasto & Parmasto (1997), Parmasto (2001b) and Tortić (1998) consider the species as indicative of old forests not much modified by man, resp. in Estonia and former Yugoslavia. The species is listed among the species indicative of spruce-dominated old forests in Finland by Kotiranta & Niemelä (1996), but not by Lindgren (2001) for NW Russian Karelia and adjacent areas in Finland.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from summer till autumn (June-October).

Frequency

Number of currently known sites: About 650 (nearly 90 % of which in Sweden and Finland).

Changes in frequency: In Finland a decrease is reported for the last 50 years, in Sweden for the last 100 years. In France and Poland no changes have been noticed. In Czech Republic an increase in the number of sites is reported for the last decades.

Threats and conservation

Threats: Sites are mainly threatened by deforestation of old-growth forest habitats as a result of silvicultural intensification.

Status of conservation: The species is red listed in Czech Republic, Finland, France, Norway, Poland, Russia (regional red lists), Slovakia and Sweden. See also Dahlberg & Croneborg (2003, 2006).

Amylocystis lapponica (Romell) Bondartsev & Singer
Basidiomycota, Polyporales, Fomitopsidaceae

Synonym: *Polyporus lapponicus* Romell

Note: Bondartsev & Singer (in Singer 1944) describe the genus *Amylocystis* and publish the combination *Amylocystis lapponicus*. This ending is against the use in botany, where names ending with “-cystis” are considered feminine. We thus have to say *Amylocystis lapponica*. This last spelling is used in *Nordic Macromycetes* (vol. 3: 231) and the genus is also considered as feminine in the name *Amylocystis hibernica* (Berk. & Broome) Teixeira.

Brief description

A polypore with annual, soft, dirty whitish carpophores, becoming dark reddish brown on bruising or drying, with a slightly bitter taste reminiscent of anise. It is typically a boreal species, which grows saprotrophically on dead spruce (*Picea abies*) trunks in taiga. It is a good indicator species for virgin spruce forests and it is threatened by silvicultural intensification.

Geography

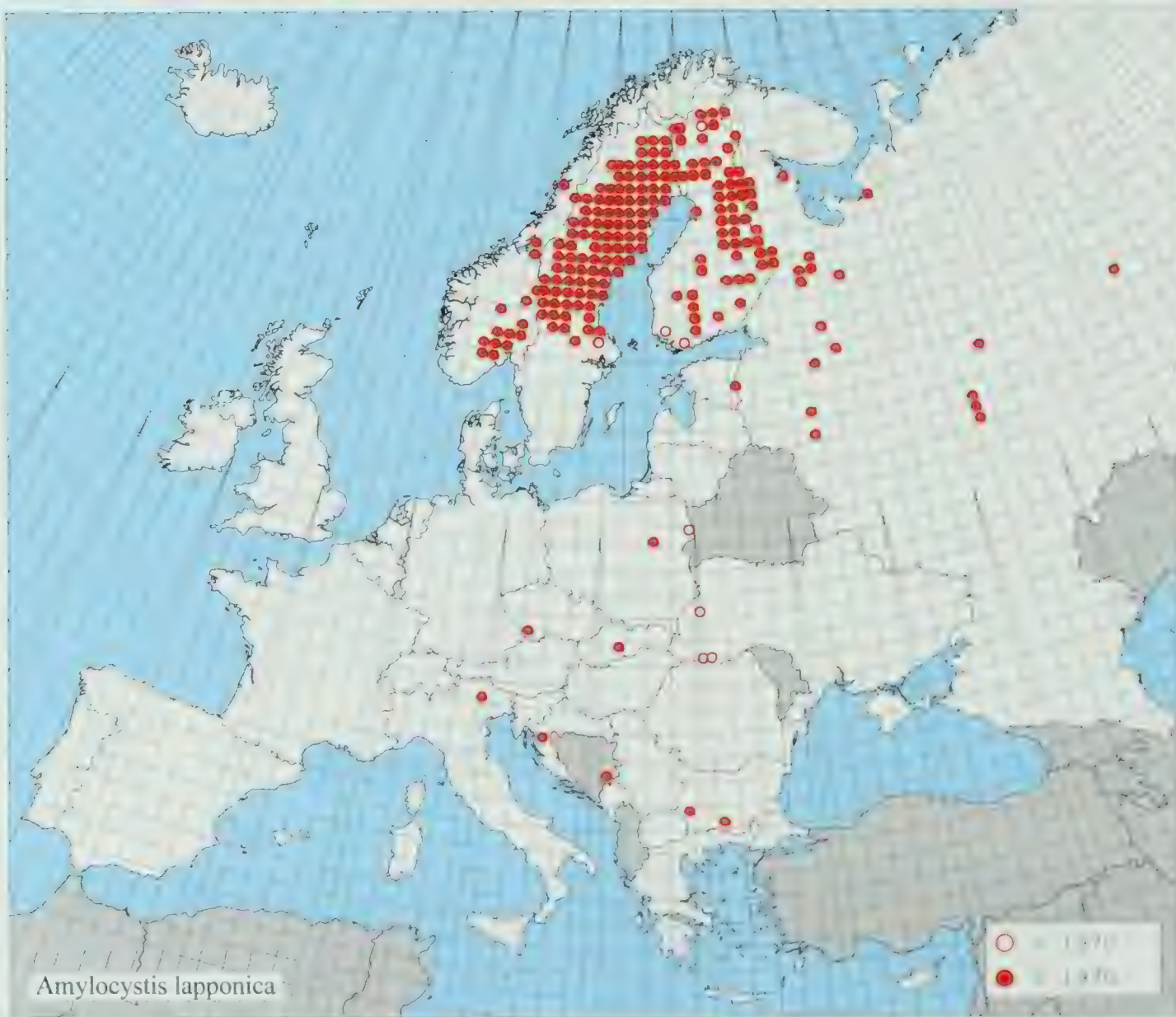
Global distribution: The species is circumboreal and present in coniferous forest ecosystems in Europe, Asia (Siberia, China) and North America (USA, Canada).

Bibliography: Jenssen & Ryvarden (1978), Kotiranta & Niemelä (1981), Gilbertson & Ryvarden (1986), Ryvarden & Gilbertson (1993), Volk et al. (1994), Niemelä et al. (2001), Núñez & Ryvarden (2001), Boulet (2003), Dai (2012), Ryvarden & Melo (2014).



Amylocystis lapponica

Photo Heikki Kotiranta



Distribution in Europe: The species mainly occurs in the lowlands, only exceptionally in lower mountain regions (Bosnia, Bulgaria, Croatia, Czech Republic, Sweden).

The dot in Bosnia has been added after Tortić (1984). Kotiranta & Niemelä (1981) propose the interesting hypothesis that “The northern tendency of *A. lapponica* may be caused more by the presence of old forests in Lapland than by climatic factors. This is also suggested by its occurrence in the lowland virgin forest of Białowieża, Poland” (see also p. 19). After Kotiranta (in e-litt.), the species is more common in Russia than in Sweden and in Finland.

Areal diagnosis for Europe: Typically Bor., with a few occurrences scattered in Sarm., CEur. and Alp.; absent from Arct., Atl., Therm., Medit. and Step.

Trophism, hosts and substrates

The fungus is a lignicolous saprotroph and probably colonizes exclusively lying trunks of *Picea abies*, moderately decayed and often still partly corticated. There is one record on *Larix decidua* (Italy), another on *Abies alba* (Bulgaria) and it seems that the species can also grow on *Abies* in the Ural Mountains (H. Kotiranta, pers. comm.). The presence of the species on these last two hosts is confirmed in Europe by Ryvarden & Gilbertson (1993). Hermansson (1997, Russia) cites also *Pinus sibirica* and *P. sylvestris* as occasional

hosts and one collection on *Betula*. Renvall et al. (1991) cite *Pinus sylvestris* as a host for 3% of the collections in Lappland and *Picea obovata* for 97%. In Finland, the species is frequently associated with *Fomitopsis rosea*, *Phlebia centrifuga* and *Phellinus ferrugineofuscus* (Renvall et al. 1991).

Habitat

Vegetation: The species almost exclusively occurs in boreal old-growth forests with *Picea abies* (*Vaccinium myrtillus* type and others). It is typically bound with taiga (Ryvarden 1993a, 1993b). Outside the boreal zone, the habitat is more diverse. In Estonia the fungus was found in a rather nitrogen rich boreo-nemoral coniferous forest (*Aegopodium* type). The sites in Croatia, Slovakia and western Ukraine are characterized as virgin beech-spruce-fir forests and, for the Czech Republic, a natural spruce forest is recorded (Domański S. 1959, Holec & Kučera 2007).

Syntaxa of vegetation: FORESTS: *Vaccinio uliginosi-Pinetum*, *Tilio-Carpinetum*, *Quercu-Carpinetum* (all Poland), *Bazzanio-Piceetum* (Czech Republic), *Piceion excelsae* (Slovakia), *Vaccinio-Piceetum* (Bulgaria, Russia), *Melico nutantis-Piceetum* (Russia).

Natura 2000 habitats: Western Taiga (code 9010, Estonia, Finland, Sweden), Fennoscandian herb-rich forests with *Picea abies* (code 9050, Finland), *Asperulo-Fagetum* beech forests (code 9130, Slovakia), *Galio-Carpinetum* oak-hornbeam forests (code 9170, Poland), Bog woodland (code 91D0, Poland), Moesian silver fir forests (code 91BA, Croatia), Acidophilous *Picea* forests of the mountain to alpine levels (*Vaccinio-Piceetea*) (code 9410, Slovenia), Alpine *Larix decidua* and/or *Pinus cembra* forests (code 9420, Italy).

Soil requirements: Because the species is lignicolous, soil characters should be without relevance. According to the ecological preferences of *Picea abies* the soils of the sites should be wet to damp and more or less acid.

Synanthropy: The species is mainly restricted to natural forests and is to be regarded as anthropophobic.

Indicator value: The species is a very good indicator for virgin spruce forests and it could be a good indicator species to point out species-rich spruce forest areas in special need of conservation (Rosok 1998, Sippola et al. 2001, Holec & Kučera 2007). The species is listed



Amylocystis lapponica.
Photo Tom H. Hofton

among the species indicative of virgin spruce-dominated forests, in Finland by Kotiranta & Niemelä (1996) and in NW Russian Karelia and adjacent areas in Finland by Lindgren (2001). Parmasto & Parmasto (1997) and Tortić (1998) cite the species among the indicator species of old forests, not much modified by man, resp. in Estonia and former Yugoslavia.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from summer till autumn (July-October).

Frequency

Number of currently known sites: About 1000, by far the majority of which being located in Sweden (also Finland and Norway).

Changes in frequency: In Finland and Sweden a decrease has been noticed for the last 50 years.

Threats and conservation

Threats: Sites are mainly threatened by silvicultural intensification (transformation of old-growth *Picea abies* forests into managed forests and, first of all, clear felling; see Sippola et al. 2001).

Status of conservation: The species is red listed in Bulgaria, Croatia, Czech Republic, Estonia, Finland, Norway, Poland, Russia (regional red list), Slovakia, Sweden. It is protected by law in Croatia, Czech Republic and Slovakia (the single known locality in Slovakia is protected as nature reserve). The species is included in the IUCN *Global Fungal Red List Initiative* (see their web-site). See also Dahlberg & Croneborg (2003, 2006).

Antrodia albobrunnea (Romell) Ryvarden

Basidiomycota, Polyporales, Fomitopsidaceae

Synonyms: *Polyporus albobrunneus* Romell, *Poria albobrunnea* (Romell) D.V. Baxter, *Leptoporus albobrunneus* (Romell) Pilát, *Tyromyces albobrunneus* (Romell) Bondartsev, *Coriolellus albobrunneus* (Romell) Domański

Brief description

A resupinate, whitish then reddish brown polypore. It is typically a boreal species, growing saprotrophically on dead logs of coniferous trees, especially Scots pine (*Pinus sylvestris*). It is a good indicator species for unmanaged old boreal pine forests and it is mainly threatened by the intensification of silvicultural practices.

Geography

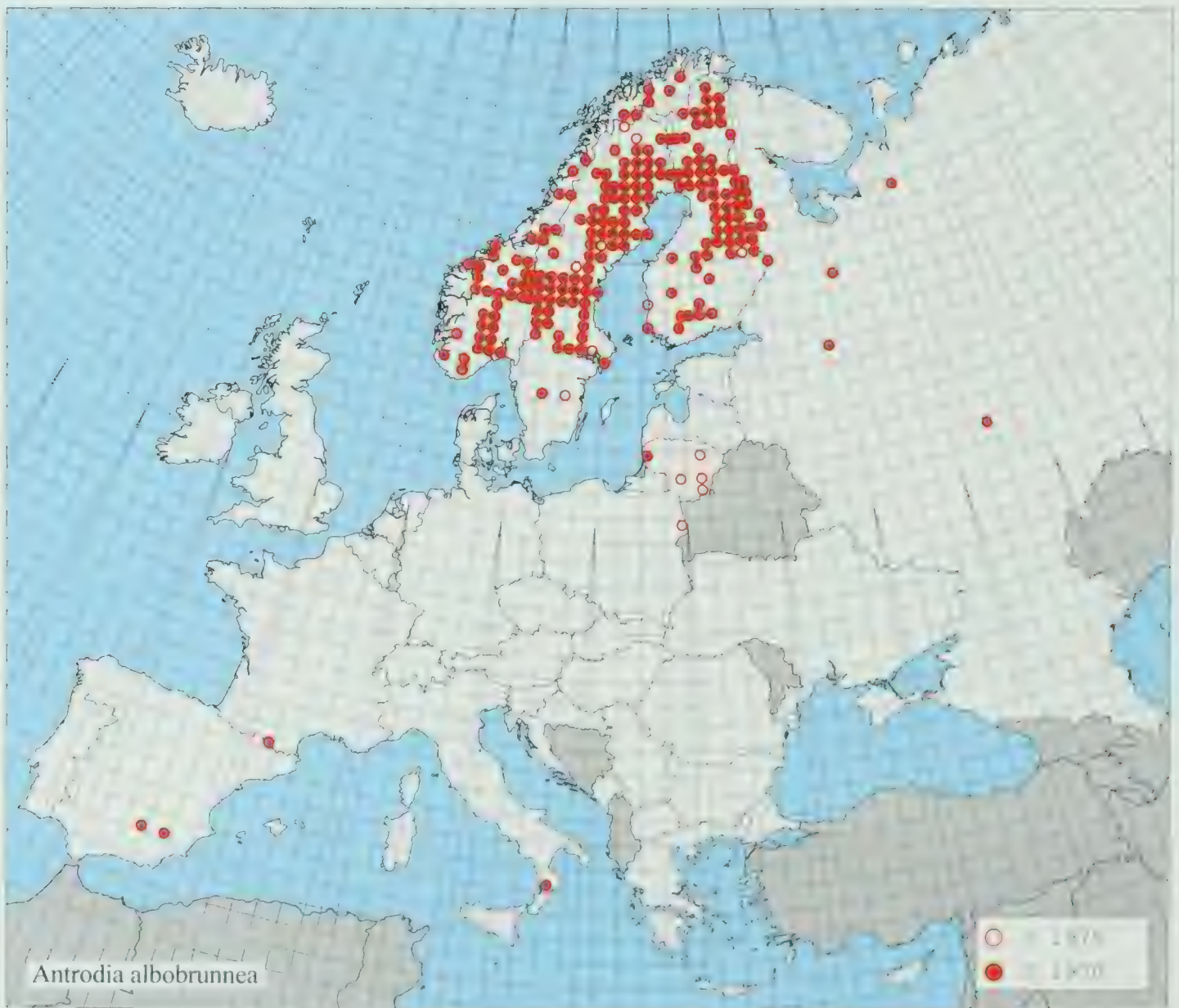
Global distribution: Circumpolar [“circumboreal” would probably be more appropriate] in the conifer zone, but restricted to high altitudes and areas with continental climate (Ryvarden & Gilbertson 1993, Ryvarden & Melo 2014): Europe, Asia (Siberia, China), North America (USA, Canada).

Bibliography: Gilbertson & Ryvarden (1986), Volk et al. (1994), Niemelä et al. (2001), Núñez & Ryvarden (2001), Piątek (2005b).



Antrodia albobrunnea

Photo Tom H. Hoffon



Distribution in Europe: The species mainly occurs in the lowlands, only exceptionally in mountainous regions (Spain, Sweden).

Besides localities indicated on the map, the species is also present in Belarus (fide Maslovsky 2004). There is a published mention of the species in Estonia (Kalmeti 1973) but Estonian mycologists consider it as very doubtful (I. Saar, in e-litt.) and we did not include it in this study. Ryvar den & Gilbertson (1993) mention the species in France and Germany and Ryvar den & Melo (2014) in former Yugoslavia, but we could not find any confirmation of its presence in those countries. According to H. Kotiranta (in litt.), the species is more frequent in some parts of Russia than indicated on the map and Hermansson (1997) says it is “widespread and frequent” in the Pechoro-Ilych biosphere reserve (Komi Republic).

Areal diagnosis for Europe: Typically Bor., with also very few occurrences scattered in Arct., Sarm. (mainly old data), Atl. (Norway), C-Eur. (north), Alp. and Medit.; absent from Therm. and Step.

Trophism, hosts and substrates

The fungus is a lignicolous saprotroph which probably exclusively colonizes coarse wood of *Pinus sylvestris* in Fennoscandia. However, there is one record on *Picea abies* in Lith-

uania and the species has been mainly found on that host in central Ural (Kotiranta et al. 2007). Bernicchia (2005) mentions *Pinus nigra* subsp. *laricio* as a host (probably for the Italian record, in the Calabria national park) and Hermansson (1997) says it has been rarely collected on *Pinus sibirica* in the east of the European part of Russia (Komi Republic). The Spanish records have been collected on *Pinus nigra* subsp. *salzmanii* (Ortega & Tellería 2000). The colonized pine wood is decorticated and often fairly to strongly decayed. The species fruits typically on lying trunks (almost invariably on the underside, after Renvall et al. 1991), in Lithuania it has also been recorded on stumps. The Finnish report emphasises the frequent occurrence on fallen “kelo trees” (debarked, standing pines, died several hundred years ago, see Niemelä et al. 2002).

Habitat

Vegetation: The species has a striking preference for boreal forests (taiga, see Ryvar den 1993a). It grows in rather dry coniferous forests with Scots pine (*Pinus sylvestris*).

Syntaxa of vegetation: FORSTS: *Dicrano-Pinion* (Poland), *Vaccinio myrtilli-Pinetum* (Russia: Leningrad Region).

Natura 2000 habitats: Western Taïga (code 9010, Finland, Lithuania, Sweden), Coniferous forests on, or connected to, glaciofluvial eskers (code 9060, Finland, Lithuania, Sweden), Acidophilous *Picea* forests of the mountain to alpine levels (*Vaccinio-Piceetea*) (code 9410, France), Mediterranean pine forests with endemic black *Pinus* (code 9535, Italy).

Soil requirements: Because the species is lignicolous, soil characters should be without relevance. According to the ecological preferences of *Pinus sylvestris* the soils of the sites should be more or less dry and acid.

Synanthropy: The fungus is mainly restricted to natural and near-natural forests.

Indicator value: The species is a good indicator for unmanaged old boreal pine forests (see p. 19). It is listed among the species indicative of both virgin spruce-dominated and virgin pine-dominated forests, in Finland by Kotiranta & Niemelä (1996) and in NW Russian Karelia and adjacent areas in Finland by Lindgren (2001).

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from summer till autumn (July-October).

Frequency

Number of currently known sites: About 400.

Changes in frequency: In Finland, Lithuania and Sweden, a decrease has been noticed for the last 50 years.

Threats and conservation

Threats: Sites are mainly threatened by silvicultural intensification.

Status of conservation: The species is red listed in Finland, Norway, Poland and Sweden. See also Dahlberg & Croneborg (2003, 2006).

Laricifomes officinalis (Vill.: Fr.) Kotl. & Pouzar

Basidiomycota, Polyporales, Fomitopsidaceae

Synonyms: *Fomitopsis officinalis* (Vill.: Fr.) Bondartsev & Singer, *Ungulina officinalis* (Vill.: Fr.) Pat.

Note 1: *Boletus officinalis* Vill., *Hist. Pl. Dauph.* **3**: 1041 (1789) is sanctioned by Fries, *Systema mycol.* **1**: 365. Therefore, it must be used as the basionym, even if it is a later synonym of *Boletus officinalis* Batsch, *Flench fung.*: 111 (1783) (Art. 15.1).

Note 2: Given that monophyly of *Laricifomes officinalis* with *Fomitopsis* core group has been rejected by molecular analysis (Kim et al. 2005), we kept the species in the genus *Laricifomes*.

Brief description

A polypore producing perennial, rather large, ungulate fruitbodies with a soft chalky white context, which has a very bitter taste. It is mainly present in the Alps but also in mountainous regions of Poland and in a few other places. It grows as a weak parasite, almost exclusively on old larches (*Larix decidua*). The species is a good indicator for old mainly undisturbed subalpine *Larix* forests. It is mainly threatened by cutting of old *Larix* trees and by logging of subalpine forests.



Geography

Global distribution: Europe, Africa (Morocco), Asia (Turkey, Siberia, Russian Far East, China, Japan, Mongolia, Korea, India), North America (Canada, USA).

Bibliography: Dörfelt (1992), Zhao & Zhang (1992), Senn-Irlet (1994), Teng (1996), Mao (2000), Núñez & Ryvarden (2001), Chlebicki & Łuszczynski (2002), Chlebicki et al. (2004, who give many bibliographic references not cited here), Piętka & Szczepkowski (2004), Doğan et al. (2005), Sesli & Denchev (2008), Dai (2012).

Distribution in Europe: The species mainly occurs in high mountain and subalpine regions, only exceptionally in the lowlands and uplands (Germany, Lithuania, Poland and Russia) (Piętka & Szczepkowski 2004, Wojewoda 2010).

Besides localities indicated on the map, it seems that the species is also present in Belarus (fide Chlebicki & Łuszczynski 2002, Piętka & Szczepkowski 2004). A very old and vague mention from Greece is made by Landerer (1858), another one is made by Zerova (1972) for Ukraine. The main area of the species (Alp. and Sarm.) coincides with the natural distribution of its host, *Larix decidua* (see the map below). The other observations have mainly been made in connection with planted trees (synanthropy). After Mukhin (1993), the fungus is a Pleistocene remnant (glacial period).

Areal diagnosis for Europe: Mainly Alp. and Sarm. (Poland); scattered observations in Bor. (Russia), Atl. (Netherlands, Spain), C-Eur. (south), Medit. (Spain) and Therm. (Turkey); absent from Arct. and Step.

Trophism, hosts and substrates

The species is a weak parasite (perthobiont) and colonizes almost exclusively very old trees of *Larix decidua* (in Poland *L. decidua* subsp. *polonica*). Telleria (1980) reports a Spanish collection on *Pinus nigra* subsp. *salzmannii* (= *P. clusiana*) and says that the species can also grow on *Abies*. In the European part of Russia, it also grows on *Pinus sibirica* (Bondartsev 1953) and on *Larix sibirica* (Hermansson 1997). The fruitbodies are devel-



Distribution of *Larix decidua* in Europe. From *Atlas Florae Europaeae* 2 (Jalas & Suominen 1973). Courtesy of the Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo.



Laricifomes officinalis

Photo Béatrice Senn-Irlet

oped at bark lesions of the trunk. They grow on old trees, both alive and dead (Hermansson 1997).

Habitat

Vegetation: The species is very characteristic of virgin subalpine larch forests. It has been exceptionally found on planted *Larix* trees outside the Alps and Sudetes, e.g. in Lithuania in a city park.

Syntaxa of vegetation: FORESTS: *Dicrano-Pinion*, *Vaccinio-Pinetum cembrae* (Germany, Slovakia), *Pulsatilla-slavicae-Pinion* (Slovakia), *Quercus robur-Pinetum* (Poland), *Seslerio rigidae-Pinetum sylvestris*, *Saxifraga-cuneifoliae-Laricetum* (both Romania), *Vaccinio-Pinetalia sibirica* (Russia); SHRUBS: *Rhododendro-Vaccinion*, *Juniperion nanae* (both France).

Natura 2000 habitats: Western Carpathian calcicolous *Pinus sylvestris* forests (code 91Q0, Slovakia), Alpine *Larix decidua* and/or *Pinus cembra* forests (code 9420, Austria, France, Germany, Italy, Romania, Slovakia, Slovenia, Switzerland).

Soil requirements: Since the species is lignicolous, soil characters should be of little importance. The host *Larix decidua* prefers base-rich soils (e.g. renzina) in high mountain and subalpine regions.

Synanthropy: The fungus occurs almost exclusively in natural forests (very rarely in plantations). However, according to Chlebicki & Luszezyński (2002) and Chlebicki et al. (2004), lowland localities of the larch in Lithuania, Belarus and the European part of Russia are of anthropogenic origin.

Indicator value: The species is a good indicator for old mainly undisturbed subalpine *Larix* forests.

Occurrence of fruitbodies (phenology)

Basidiocarps are perennial and can thus be found all year round. It seems they can sometimes remain active during a very long period of time, sometimes reaching 60-80 years, attaining huge dimensions and considerable weight (up to 10 kg) (Bondartsev 1953, Chlebicki & Łuszczynski 2002).

Frequency

Number of currently known sites: About 80 (nearly 80 % of which in France and Switzerland).

Changes in frequency: In Lithuania and Spain there are no records after 1968. In France, Poland, Slovakia and Slovenia a decrease has been noticed for the last 50 to 100 years.

Threats and conservation

Threats: Sites are mainly threatened by cutting of old *Larix* trees and by logging of subalpine forests (e.g. to construct facilities for winter sports). In some regions, fruitbodies are collected and used as traditional medicine (Piętka & Szczepkowski 2004, Ryvarden & Melo 2014).

Status of conservation: The species is red listed in Austria, France, Germany, Iberian Peninsula (Spain + Portugal), Lithuania, Poland, Slovakia and Switzerland. It is protected by law in Germany, Lithuania, Poland, Russia (regional red lists) and Slovenia. See also Dahlberg & Croneborg (2003, 2006).



Laricifomes officinalis

Photo Marco Floriani

***Pycnoporellus alboluteus* (Ellis & Everh.) Kotl. & Pouzar**
Basidiomycota, Polyporales, Fomitopsidaceae

Synonyms: *Fomes alboluteus* Ellis & Everh., *Hapalopilus alboluteus* (Ellis & Everh.) Bondartsev & Singer, *Phaeolus alboluteus* (Ellis & Everh.) Ames

Brief description

A polypore forming large resupinate annual basidiocarps, which are soft fleshed and bright orange when fresh, with large pores which can split to form a hydnnaceous hymenophore. It is very rare in Europe and mostly present in the Boreal domain. It is a lignicolous saprotroph growing on trunks and thick branches, mostly of very old spruce (*Picea abies*). It mainly grows in autumn, in old spruce forests and is mainly threatened by deforestation of old-growth forest habitats.

Geography

Global distribution: Europe, Asia (Siberia, Georgia, China), North America (USA, Canada), South America (Venezuela).

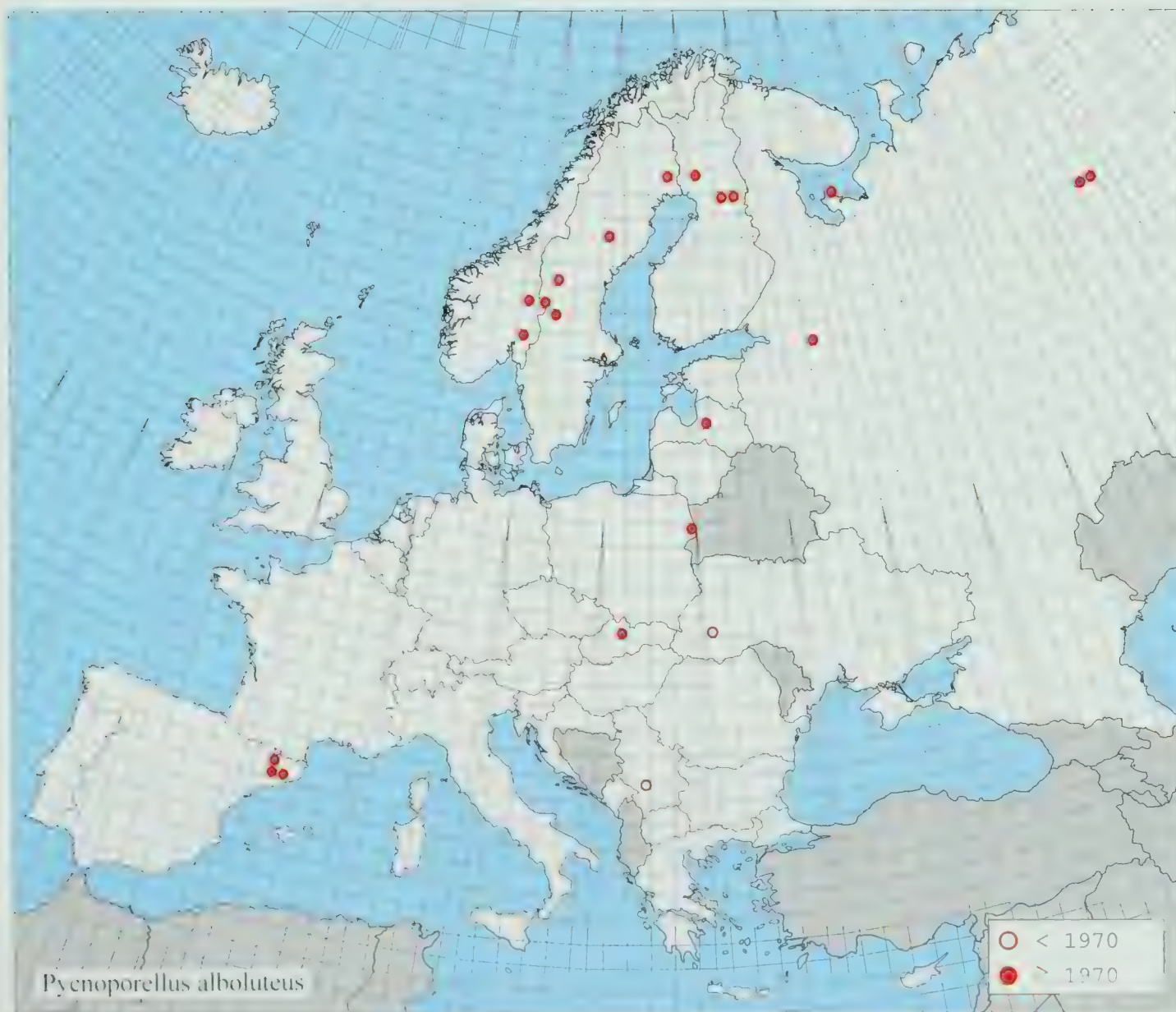
Bibliography: Bondartsev (1953), Kotlaba & Pouzar (1963), Hintikka (1970), Tortić & Jelić (1974, European map), Niemelä (1980), Gilbertson & Ryvarden (1987), Tabarés & Rocabrana (1991), Zhao & Zhang (1992), Ryvarden & Gilbertson (1994, European map), Volk et al. (1994), Teng (1996), Bessette et al. (1997), Hermansson (1997), Niemelä et al. (2001), Delgado et al. (2002), Piątek (2002, 2003), Boulet (2003).

Distribution in Europe: The species occurs from the lowlands to mountainous regions (Spain, in Serbia also above 1200 m).



Pycnoporellus alboluteus

Photo Heikki Kotiranta



The mention from Croatia by Piątek (2002) is most probably a lapsus for Serbia. Ryvar- den & Gilbertson (1994, map) mention the species in Belarus and Romania but we do not know any observation from these two countries.

Areal diagnosis for Europe: Mainly Bor. and Sarm. (west); very rare in C-Eur. (one men- tion in Norway), Alp. (one mention in Slovakia), Therm. (one old mention in Serbia) and Medit. (Spain); absent from Arct., Atl. and Step.

Trophism, hosts and substrates

The species is a lignicolous saprotroph living on trunks and thick branches (always lying?). It mainly decays wood of *Picea abies*, seldom of *Alnus incana* and *Populus tremula* (both Finland). The Spanish record has been made on *Pinus halepensis* (Tabarés & Rocabruna 1991). Ryvar- den & Gilbertson (1994) and Ryvar- den & Melo (2014) say “especially *Picea* but also found on *Abies*”. Niemelä (1980) mentions a series of hosts (*Larix*, *Pinus*, *Pseudot- suga*, *Tsuga* and various species from the genera *Picea* and *Abies*) but some of them have probably never been observed in Europe. It is reported from Finland that the fungus always inhabits wood pre-colonized and already more or less degraded by *Fomitopsis pinicola* (Kotiranta et al. 2009). Several times the species was found under loosened bark (Finland).

Habitat

Vegetation: The fungus is restricted to forests with spruce. From Finland the dominant occurrence in luxuriant *Picea abies* dominated old-growth forests is notified. From Slovakia a virgin forest is reported as habitat for the single locality. It seems that the fungus requires a high moisture level (Hermansson 1997). See also Niemelä (1980).

Syntaxa of vegetation: FORSTS: *Quercus-Carpinetum* (= *Tilio-Carpinetum betuli*) (with *Picea*, Poland), *Vaccinio-Piceetea* (Russia).

Natura 2000 habitats: Western Taïga (code 9010, Estonia, Finland, Latvia, Sweden), Fennoscandian herb-rich forests with *Picea abies* (code 9050, Finland, Poland, Sweden), *Asperulo-Fagetum* beech forests (code 9130, Slovakia), *Galio-Carpinetum* oak-hornbeam forests (code 9170, Poland).

Soil requirements: Since the species is lignicolous, soil characters should not be of great importance. According to the ecological preferences of the main host (*Picea abies*) the soils of the sites should be wet to damp and more or less acid.

Synanthropy: The species is restricted to forests mainly not or seldom moderately influenced by man and is to be regarded as anthropophobic.

Indicator value: The species is a good indicator for undisturbed spruce forests.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from summer till autumn (July-October).

Frequency

Number of currently known sites: About 25 (more than 90 % of which in Finland and Sweden).

Changes in frequency: In Finland, Poland and Slovakia no changes have been noticed.

Threats and conservation

Threats: Sites are mainly threatened by deforestation of old-growth forest habitats in consequence of silvicultural intensification.

Status of conservation: The species is red listed in Finland, Norway, Poland, Russia (regional red list), Serbia, Slovakia and Sweden. In Serbia, the fungus is protected by law. See also Dahlberg & Croneborg (2003, 2006).

Podoscypha multizonata (Berk. & Brome) Pat.

Basidiomycota, Polyporales, Meruliaceae

Synonyms: *Thelephora multizonata* Berk. & Broome, *Stereum multizonatum* (Berk. & Broome) Massee

Note: The species is easily confused with *Cotylidia pannosa* and misidentifications occurred in the past (Reid 1965, Jahn & Müller 1976, Pirlot 1991). *C. pannosa* differs mainly by its monomitic context and simple septate hyphae (dimitic context and clamped generative hyphae in *P. multizonata*); macroscopically by the whitish to yellowish colour of the sterile surfaces, which are reddish to vinose brown in *P. multizonata*.

Brief description

A remarkable stereoid species, forming more or less erect rosettes of pinkish ochre lobes, with darker zones. It is absent from northern Europe and mainly present in the Atlantic domain. It is a lignicolous species living as a weak parasite or as a saprotroph on buried roots or on the basis of old tree trunks, mainly of oak (*Quercus petraea* and *Q. robur*), sometimes of beech (*Fagus*). It is mainly threatened by felling of old oaks and beeches.

Geography

Global distribution: Europe, Asia (Caucasus, Russian Far East).



Podoscypha multizonata

Photo François Valade



Distribution in Europe: The species mainly occurs in the lowlands, only seldom in mountainous regions (Spain; in Bulgaria even above 1200 m).

Besides localities indicated on the map, the species is also mentioned from Slovenia by Bernicchia & Gorjón (2010), but we did not receive confirmation of its presence in that country. With exception of the two localities in southern Spain, the distribution of the fungus is included in the area of one of the main hosts, *Quercus petraea* (see Jalas & Suominen 1976: map 299). See also Reid (1965), Jahn & Müller (1976), Legon & Pegler (1996), Fraiture & Walley (2005) and Overall & Mottram (2006).

Areal diagnosis for Europe: Mainly Atl. and C-Eur.; very rare in Alp., Therm. and Medit.; absent from Aret., Bor., Sarm. and Step.

Trophism, hosts and substrates

The fungus is lignicolous and lives as a saprotroph on buried roots or as a weak parasite (perthobiont) on the trunk basis of living old trees. It colonizes mainly *Quercus petraea* (e.g. Serbia) and *Q. robur* (e.g. UK), rather seldom also *Fagus sylvatica* (e.g. Bulgaria, Germany). Bernicchia & Gorjón (2010) also cite *Quercus ilex* and *Q. suber* as hosts.

Habitat

Vegetation: The fungus occurs in different biotopes with old oaks and beeches. It is reported from deciduous forests, pasture-woodlands (UK) and from parks (e.g. Germany, Slovakia).

Syntaxa of vegetation: FORESTS: *Galio odorati-Fagenion* (Germany), *Carpinion betuli* (France, Germany, UK), *Asperulo-Fagetum* (France, Switzerland, UK), *Luzulo-Fagetum* (Bulgaria, Slovenia).

Natura 2000 habitats: *Luzulo-Fagetum* beech forests (code 9110, Bulgaria, Slovenia), Atlantic acidophilous beech forests with *Ilex* and sometimes also *Taxus* in the shrublayer (code 9120, France), *Asperulo-Fagetum* beech forests (code 9130, France, Switzerland, UK), Sub-Atlantic and Medio-European oak or oak-hornbeam forests of the *Carpinion betuli* (code 9160, France, Germany, UK), Old acidophilous oak woods with *Quercus robur* on sandy plains (code 9190, Slovakia, UK).

Soil requirements: Since the species is lignicolous, soil characters should be of little importance. Reports exist for sand, brown soil and calcareous soil.

Synanthropy: The species occurs in forests, woodlands and in parks moderately influenced by man.

Indicator value: The fungus indicates wooded areas with old ailing or already dead oaks and beeches.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from summer till autumn (August-November). The fruitbodies are rather persistent and are still identifiable in winter.

Frequency

Number of currently known sites: About 120 (nearly 80 % of which in France and UK).

Changes in frequency: In France a minor decrease is reported for the last 4 decades. In UK and Belgium, an increase in the number of sites has been noticed (Fraiture & Walley 2005, Overall & Mottram 2006).

Threats and conservation

Threats: It is mainly threatened by felling of old oak and beech trees and by silvicultural intensification in general.

Status of conservation: The species is red listed in Hungary, the Iberian Peninsula (Spain + Portugal) and Slovakia. In Serbia, it is protected by law. The species is included in the IUCN *Global Fungal Red List Initiative* (see their web-site). See also Dahlberg & Croneborg (2003, 2006).

Hymenochaete cruenta (Pers.: Fr.) Donk
Basidiomycota, Hymenochaetales, Hymenochaetaceae

Synonyms: *Corticium cruentum* (Pers.: Fr.) J. Schröt., *Cytidia cruenta* (Pers.: Fr.) Herter, *Hymenochaete mougeotii* (Fr.: Fr.) Cooke, *Stereum mougeotii* (Fr.: Fr.) Berk.

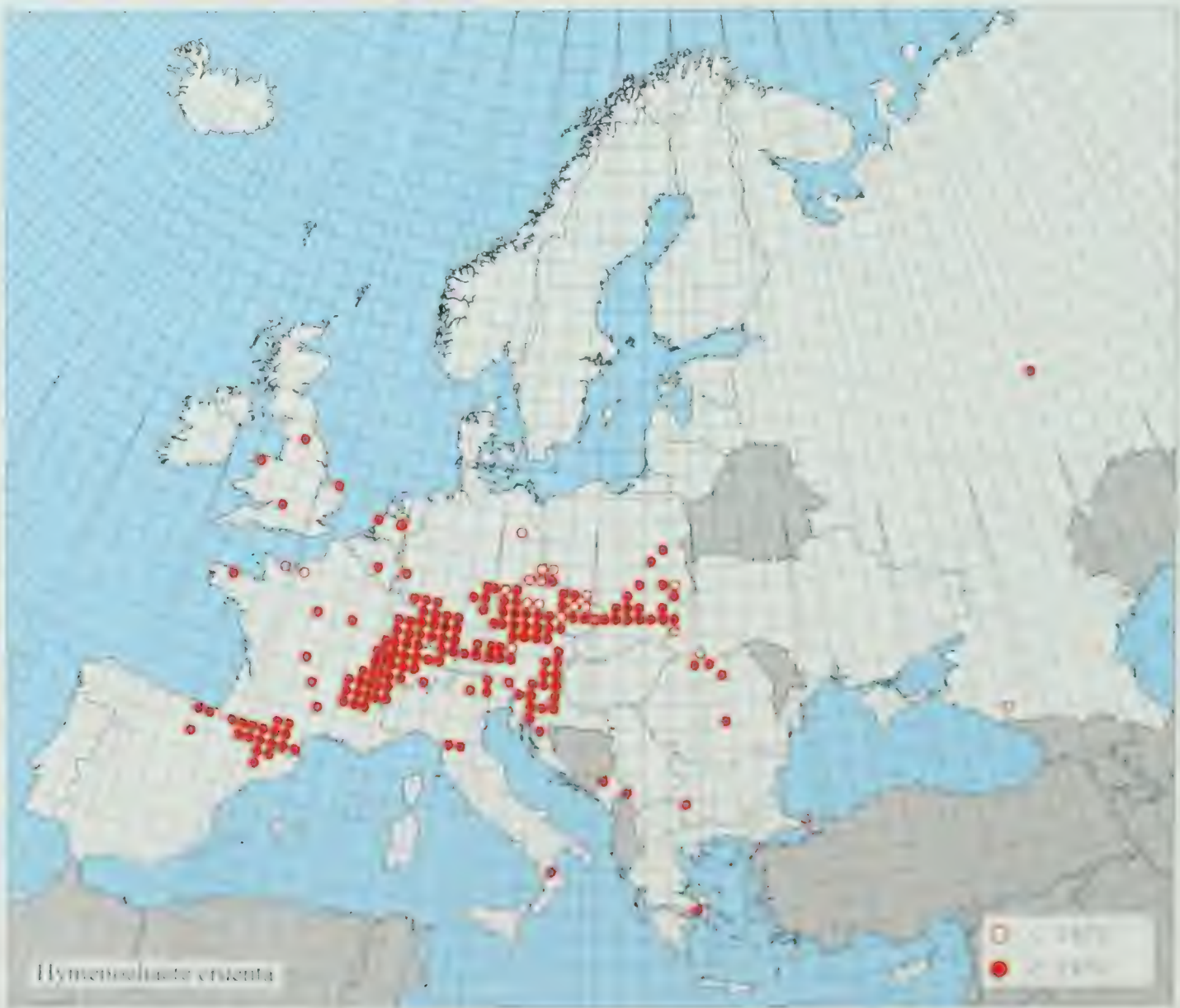
Note: Parmasto (2001a) gives a description of *Hymenochaete sphaericola* (syn. *H. murashkinskyi*), which can be confused with *H. cruenta* but grows on *Quercus* and *Rhododendron* and has wider spores.

Brief description

A corticioid (crust-like) fungus which is easy to recognize, because of its bright red, then dark red-brown colour. It is mainly present in Central-European and Alpine domains, where it lives as a weak parasite and then as a saprotroph on trunks or branches of conifers (in most cases, ailing *Abies alba*), often at a height of 10 to 30 m above ground. Basidiocarps can be found all over the year.

Geography

Global distribution: Europe, Asia (Turkey, Georgia, Siberia, India, Sri Lanka, China, North Korea, Ceylon, Japan), South America (Argentina). The mentions from Australia and New



Zealand are misidentifications for *Hymenochaete sphaericola*; the mentions from Asia on non-coniferous hosts as well (see below, under “Substratum”).

Bibliography: Butler & Bisby (1960), Tortić & Jelić (1970), Skirgiello (1972b), Lange (1974), Job (1990), Teng (1996), Mao (2000), Parmasto (2001a), Wojewoda et al. (2002), Greslebin & Rajchenberg (2003), May et al. (2003), Dai et al. (2004), Wojewoda et al. (2004), Doğan et al. (2005), Fraiture & Walley (2005), Dai & Niemelä (2006), Bernicchia et al. (2007), Bresinsky & Dörfelt (2008), Sesli & Denchev (2008), Ghobad-Nejhad et al. (2009), Bernicchia & Gorjón (2010), Gvritishvili et al. (2012).

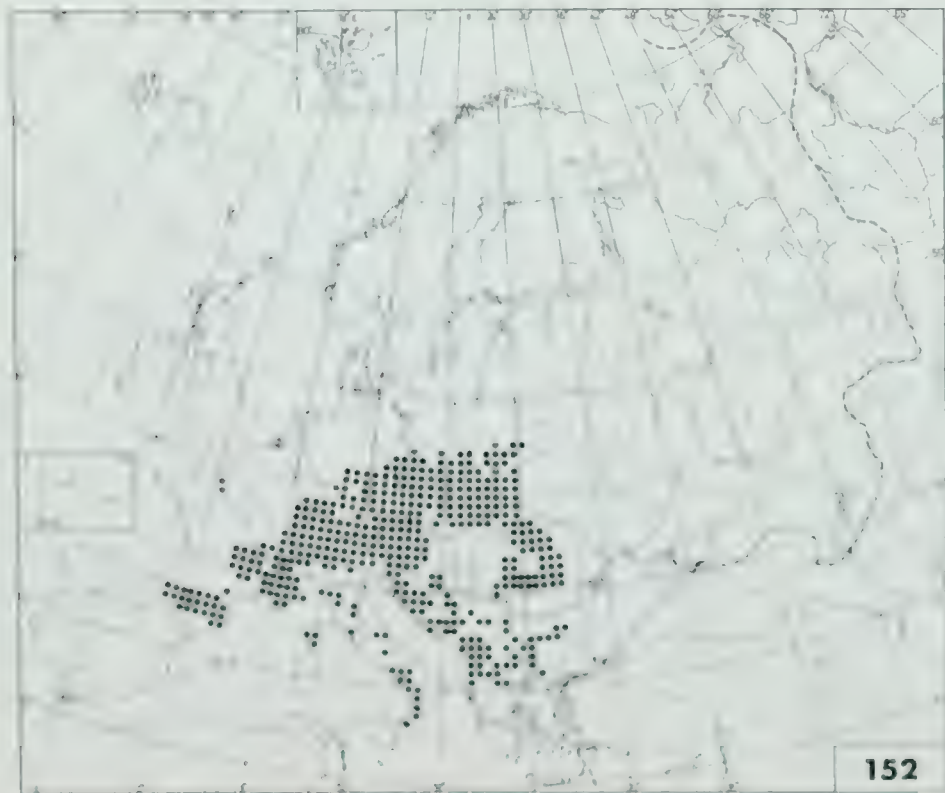
Distribution in Europe: The species mainly occurs in mountainous regions (above 1200 m e.g. in Romania, Russia, Serbia), only exceptionally in the lowlands and uplands (e.g. Netherlands, Russia).

The presence of the species in Turkey (European part) is doubtful; it is based on a single collection on *Quercus*, which is a possible confusion with *Hymenochaete sphaericola* (see Parmasto 2001a). The main distribution of the species fits well with the distribution of its main host, *Abies alba* (see the map below), even if the fungus is much less present in the Balkanic and Italian peninsulas. Scattered observations have been made on planted trees, outside the natural distribution of *Abies alba*.

Areal diagnosis for Europe: C-Eur. (south) and Alp.; scattered observations in Sarm., Atl., Therm. and Medit.; absent from Arct., Bor. and Step.

Trophism, hosts and substrates

This lignicolous fungus lives at first as a weak parasite (perthobiont) on corticated branches and trunks, in most cases of ailing trees of *Abies alba*, and then as a saprotroph on its dead host. In more eastern regions of Europe other species of Pinaceae are also colonized. In Romania and Montenegro the fungus was found on *Picea abies*. Parmasto (2001a) cites different *Abies* species (a.o. *A. sibirica*) as additional hosts and also “dubious data” on *Picea abies*. In Turkey, a record on *Quercus* could be a confusion with *Hymenochaete*



Distribution of *Abies alba* in Europe. From *Atlas Florae Europaeae* 2 (Jalas & Suominen 1973). Courtesy of the Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo.



Hymenochaete cruenta

Photo Eric Michon

sphaericola (see Parmasto 2001a). The mentions of *H. cruenta* on *Rhododendron* (Farr et al. 1996) and *Rubus* (Job 1990) most probably correspond to *H. sphaericola* but see also Léger (1998) who has a somewhat different taxonomic opinion. As the fungus often occurs on standing trees at a height of 10 to 30 metres, it is classified as aerobiont. The fruitbodies do not survive for a long time on fallen branches.

Habitat

Vegetation: The fungus mainly inhabits mountain mixed beech-spruce-fir forests. In central Europe it occurs especially at places with high humidity (e.g. northern slopes), in Netherlands and UK only in fir plantations (because *Abies* is not native there). In Romania and Serbia the species is also reported from spruce forests, in Ukraine from an oak pine forest. See also Bresinsky & Dörfelt (2008).

Syntaxa of vegetation: FORESTS: *Hordelymo-Fagetum*, *Lonicero alpigenae-Fagetum*, *Luzulo-Fagetum*, *Luzulo-Abietetum*, *Vaccinio-Abietetum*, *Homogyno-Piceetum* (all Germany), *Dentario emeaphylli-Fagetum* (Germany, Poland), *Dentario glandulosae-Fagetum*, *Abietetum polonicum*, *Abieti-Piceetum montanum*, *Bazzanio-Piceetum*, *Quercu-Piceetum*, *Pino-Quercetum* variant with *Fagus* and variant with *Abies*, *Vaccinio myrtilli-Pinetum*, *Tilio cordatae-Carpinetum betuli* (all Poland), *Galio-Abietetum* (Austria, Poland), *Oxallide acetosellae-Abietetum* (Russia), *Abieti-Fagetum* (Germany, Romania), *Piceetum excelsae croaticum* (Montenegro), *Abieti-Fagetum dinaricum* (Slovenia), *Vaccinio-Piceetum* (Bulgaria).

Natura 2000 habitats: *Luzulo-Fagetum* beech forests (code 9110, Croatia, Germany, Slovakia), *Asperulo-Fagetum* beech forests (code 9130, Poland, Slovakia), *Galio-Carpinetum* oak-hornbeam forests (code 9170, Poland), *Tilio-Acerion* forests of slopes, screes and ravines (code 9180, Czech Republic), Holy Cross fir forests (*Abietetum polonicum*) (code 91P0, Poland), Moesian silver fir forests (code 91BA, Croatia), Hellenic beech forests with *Abies borisii-regis* (code 9270, Macedonia), Acidophilous *Picea* forests of the mountain to alpine levels (*Vaccinio-Piceetea*) (code 9410, Bulgaria, Germany, Poland, Slovakia)

Soil requirements: Since the species is lignicolous, soil characters should be of little importance. According to the ecological preferences of *Abies alba*, soils should not be strongly acid but well water supplied.

Synanthropy: The species is mainly restricted to natural and near-natural forests and appears very seldom in plantations.

Indicator value: The species is a good indicator of mountain forests with *Abies alba*.

Occurrence of fruitbodies (phenology)

Basidiocarps can be found all over the year. Spores are produced during periods of high precipitation and humidity.

Frequency

Number of currently known sites: About 200 (in great majority in the Alps).

Changes in frequency: In Romania there is no record after 1975. In France and Germany a decrease has been noticed for the last decades. In Czech Republic, Netherlands and Poland, no changes of frequency were announced.

Threats and conservation

Threats: Sites are mainly threatened by silvicultural intensification (e.g. clear-cutting, planting of allochthonous trees), but also by strong air pollution because *Abies alba* is sensitive to immissions.

Status of conservation: The species is red listed in Austria, Czech Republic, France, Germany, Netherlands, Poland and Switzerland.

Boletopsis grisea (Peck) Bondartsev & Singer

Basidiomycota, Thelephorales, Bankeraceae

Synonym: *Polyporus griseus* Peck

Note: *Boletopsis perplexa* Watling & Milne (2006), has recently been described from Scotland. It is close to *B. leucomelaena* (dark colours, including the olivaceous tints, and microscopic characters) but could be confused with *B. grisea* because both species are growing in connection with *Pinus sylvestris*. Some of the specimens included in the present study could belong to *B. perplexa*.

Brief description

A stipitate polypore with a boletoid habit, grey-brown cap and stem, and whitish pores which become pinkish brown when bruised. It is mostly living in boreal and central Europe but many growthplaces are also situated in Spain and in southern France. It is a symbiotic species, forming ectomycorrhizae almost always with Scots pine (*Pinus sylvestris*) and living in oligotrophic boreal Scots pine forests and heath forests dominated by pines. It is mainly threatened by eutrophication and by the intensification of silvicultural practices.

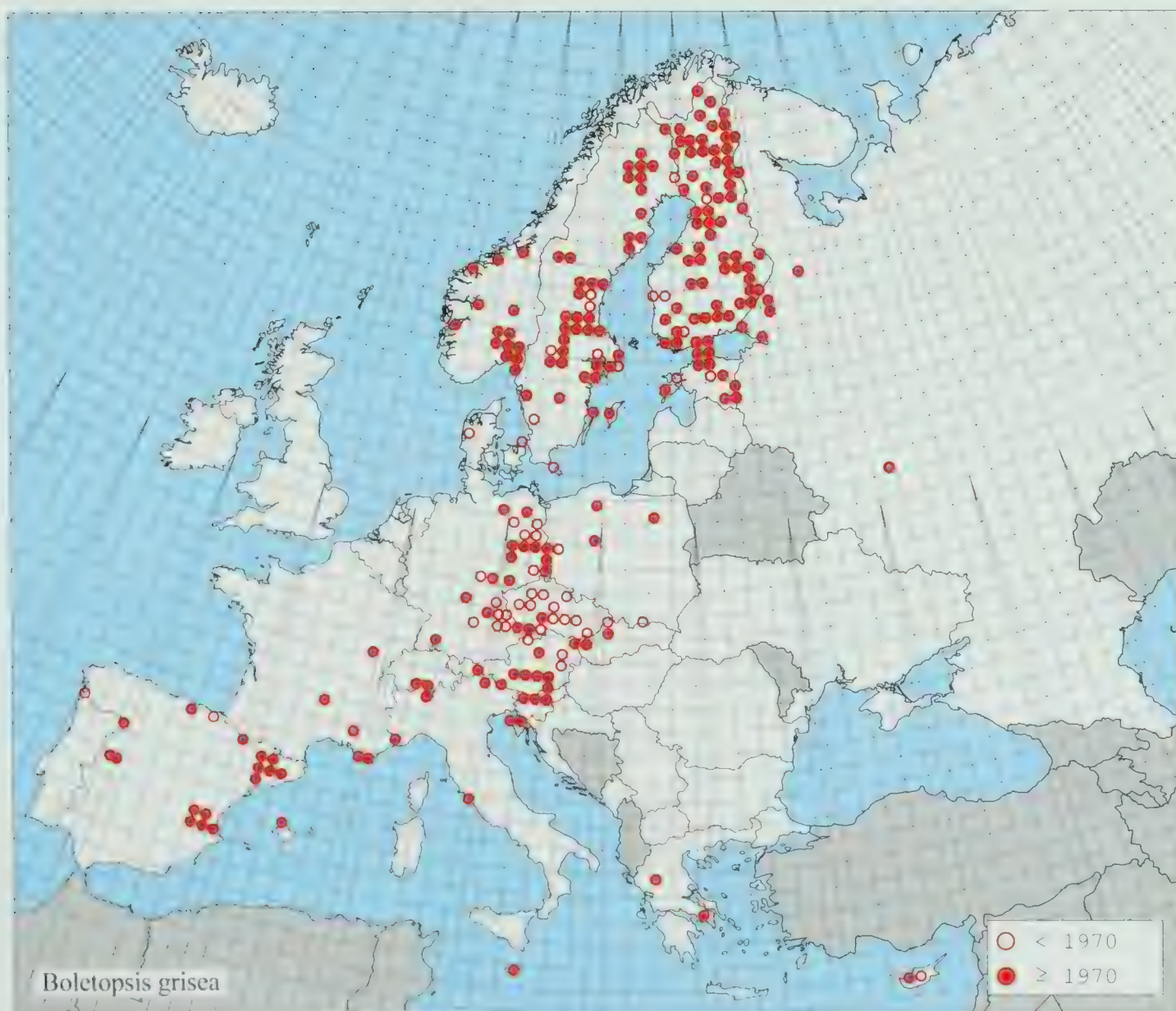
Geography

Global distribution: Europe, Asia (Siberia, Turkey, China, Japan), Africa (Morocco, Canary Islands), North America (USA, Canada, Mexico), Central America (Costa Rica).



Boletopsis grisea

Photo Daniel Ghyselinck



Bibliography: Niemelä & Saarenoksa (1989), Ryvarden & Gilbertson (1993), Bernicchia & Bertucci (1995), Adamčík & Ripková (2003), Raymundo & Valenzuela (2003), Holec (2004), Hrouda (2005a, 2005b), Mata & Ryvarden (2007), Sesli & Denchev (2008), Shiryayev (2008), Watling & Milne (2008), Dai (2012), Larouz et al. (2012).

Distribution in Europe: The species mainly occurs in the lowlands, occasionally in mountainous regions (e.g. Czech Republic, Poland, Spain, Sweden).

According to Ryvarden & Melo (2014), it seems natural to assume that the species occurs throughout Europe except for most of the area with Atlantic climate. The distribution in Fennoscandia is discussed by Niemelä & Saarenoksa (1989, map). Besides localities indicated on the map presented here, the species has also been mentioned from Romania (Hrouda 2005a) and Netherlands (Hrouda 2005b), without precise location. We did not receive any other data confirming the presence of the species in those two countries.

The distribution of the species is almost entirely included in the distribution area of its main host (*Pinus sylvestris*, see the distribution map on p. 105) but it is much narrower: the fungus is very rare in the countries of the former Eastern bloc (except Estonia, Czech Republic, Slovakia and Slovenia); it is also absent from Scotland and very rare in France and Italy.

Areal diagnosis for Europe: Mainly Bor. and C-Eur. (many old records); also present in Sarm. (western part), Alp. and Medit.; very rare in Atl. (an old mention in Denmark) and Therm.; absent from Arct. (?) and Step.

Trophism, hosts and substrates

The fungus is ectomycorrhizal and lives almost exclusively in symbiosis with *Pinus sylvestris*. Melo et al. (2007) indicate *Pinus halepensis* as the host in the Iberian Peninsula. A carpophore connected with *Pinus mugo* has been collected in Austria (Hroudá 2005a). The species grows under *Cedrus atlantica* in Morocco (Larouz et al. 2012: 2058) and has been observed in France under that tree (Bidaud 2009 and the picture presented here). It has also been mentioned in forests of *Abies cephalonica* in Greece (Pantidou 1980, sub *Polyporus griseus* Peck; but the species is not included in Zervakis et al. 1998). In the present work, records mentioning *Picea* as the host tree have been regarded as confusions with *Boletopsis leucomelaena*.

Habitat

Vegetation: The species mainly inhabits oligotrophic boreal Scots pine (*Pinus sylvestris*) forests and heath forests dominated by pines (*Calluna-Vaccinium* undergrowth), often rich in terrestrial mosses (e.g. *Dicranum* spp.) and lichens (e.g. *Cladonia* spp.). In Poland the fungus also occurs on inland sand dunes with pine, in France also in *Pinus* forests mixed with *Cedrus* and even in a pure stand of *Cedrus atlantica*. In Fennoscandia (Niemelä & Saarenoksa 1989), it is a fungus of poor habitats and grows almost exclusively in dry pine forests; in southern and central Finland in the *Calluna* and *Vaccinium vitis-idaea* types, and in the north in their equivalents. In Italy, it has also been found under *Arbutus unedo* and *Erica arborea* with very rare *Quercus cerris* (Bernicchia & Bertucci 1995, *Pinus* overlooked?). In the east of the European part of Russia (Hermansson 1997), it grows on sandy soil among lichens and mosses, and it is only observed in thin pine forests of lichen type or lichen/grass type.

Syntaxa of vegetation: FORESTS: *Dicrano-Pinion*, *Dicrano-Pinetum* (incl. *Cladonio-Pinetum* and *Leucobryo-Pinetum*; both Germany, Poland), *Pinetalia sylvestris* (France), *Erico-Pinion* (Switzerland).

Natura 2000 habitats: Western Taiga (code 9010, Estonia, Finland, Sweden), Coniferous forests on, or connected to, glaciofluvial eskers (code 9060, Finland, Sweden), Central European lichen Scots pine forests (code 91T0, Germany, Poland), Subalpine and mountain *Pinus uncinata* forests (code 9430, Spain).

Soil requirements: The fungus colonizes acid to neutral soils, in humid areas more or less dry soils (for Spain comparatively wet soils were reported). They are always nitrogen poor and more or less sandy (often podzol); the litter layer is absent or thin.

Synanthropy: The species is to be regarded as stenoeccious and anthropophobic.

Indicator value: It is a characteristic species of natural or near-natural oligotrophic pine forests and of heath forests with pines.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from summer to late autumn (August–November). It seems they occur irregularly and they can be absent some years (Hermansson 1997).

Frequency

Number of currently known sites: About 250.

Changes in frequency: In Czech Republic, Denmark, Germany and Sweden a decrease is reported for the last 4 to 6 decades (e.g. no records for Denmark since 1963). In contrast, in Estonia, Finland and Poland no changes have been noticed.

Threats and conservation

Threats: Sites are mainly threatened by eutrophication and silvicultural intensification (clearcutting).

Status of conservation: The species is red listed in Czech Republic, Denmark, Finland, France, Germany, Iberian Peninsula (Spain + Portugal), Norway, Poland, Russia (regional red list), Sweden and Switzerland. The species is included in the IUCN *Global Fungal Red List Initiative* (see their web-site). See also Dahlberg & Croneborg (2003, 2006).

***Bankera fuligineo-alba* (J.C. Schmidt: Fr.) Coker & Beers**
Basidiomycota, Thelephorales, Bankeraceae

Synonyms: *Hydnum fuligineoalbum* J.C. Schmidt: Fr., *Sarcodon violascens* var. *fuligineoalbus* (J.C. Schmidt: Fr.) Quél., *Sarcodon fuligineoalbus* (J.C. Schmidt: Fr.) Quél. var. *fuligineoalbus* **non** *Sarcodon fuligineoalbus* var. *fuligineoviolaceus* (Kalchbr. in Fr.) Quél. [= *Sarcodon fuligineoviolaceus*], *Hydnum fragile* Fr. **non** Pers.

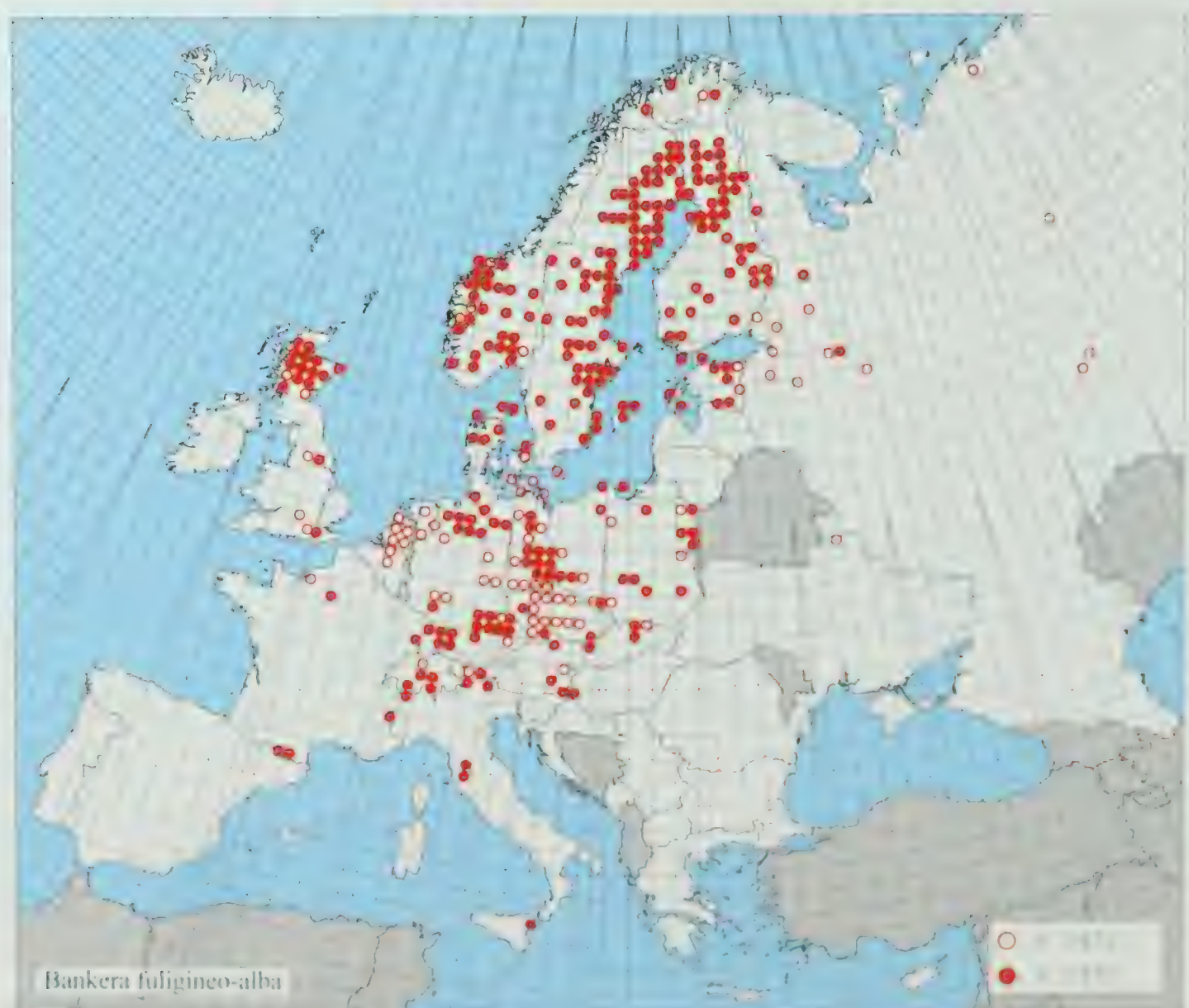
Brief description

A stipitate hydnum with a whitish then brownish carpophore, whitish spores, and a smell of curry when dried. It is mainly present in boreal and central Europe and lives in symbiosis, mostly with Scots pine (*Pinus sylvestris*), in nutrient poor pine forests. It is threatened by eutrophication and by the intensification of silvicultural practices.

Geography

Global distribution: Europe, Asia (Siberia, Armenia, Turkey, Israel, Japan), North America (Canada, USA).

Bibliography: Coker & Beers (1951), Nikolajeva (1961), Maas Geesteranus (1971), Doll (1979), Baird (1986), Gulden & Hanssen (1992), Otto (1992), Arnolds (1993), Christensen (1993), Nauta & Vellinga (1995), Pegler





Bankera fuligineo-alba

Photo Daniel Ghyselinck

et al. (1997), Doğan et al. (2005), Fraiture & Walley (2005), Hrouda (2005a, 2005b), Bresinsky & Dörfelt (2008), Sesli & Denchev (2008), Shiryayev (2008), Łuszczynski (2009), Tura et al. (2010).

Distribution in Europe: The species mainly occurs in the lowlands, occasionally in mountainous regions, and only very seldom above 1200 m (Italy).

The distribution fits quite well with the distribution of *Pinus sylvestris* (see the distribution map on p. 105) even if the fungus is very rare or absent in the southern part of that area. Besides localities indicated on the map, the species is also present in Belarus (Yurchenko 2003).

Areal diagnosis for Europe: Mainly present in Bor., Atl. (esp. northern part; many old data) and C-Eur. (many old records); also present in Sarm. (mainly west) and Alp.; a very few localities in Arct., Therm. and Medit.; absent from Step.

Trophism, hosts and substrates

The fungus is ectomycorrhizal and lives in symbiosis with *Pinus*, nearly always with *P. sylvestris* (Agerer & Otto 1997). In Denmark it also grows in dunes, with *P. mugo* (records related with *Picea* were considered as confusions with *Bankera cinerea*) (Christensen 1993).

Habitat

Vegetation: The species mainly inhabits nutrient-poor pine forests (including dunes with pines), often rich in terrestrial mosses (e.g. *Dicranum* spp.) and lichens (e.g. *Cladonia*

spp.); typical seed plants are e.g. *Avenella flexuosa* and *Vaccinium vitis-idaea*. It has occasionally been found in pine plantations (e.g. afforestation in former brown coal mining areas, Germany) and exceptionally in parks. In the Mediterranean region it is also observed in sclerophyllous forests with *Pinus* and *Quercus ilex* and in chestnut coppices with pine (Italy). Gulden & Hanssen (1992) mention collections from *Picea abies* forests and plantations. Also mentioned in plantations by Newton et al. (2002). Typical associated fungi are e.g. *Boletopsis grisea*, *Sarcodon squamosus* and *Tricholoma focale*.

Syntaxa of vegetation: FORESTS: *Dicrano-Pinion* (Norway, Poland, Switzerland), *Serratulo-Pinetum*, *Vaccinio myrtilli-Pinetum*, *Peucedano-Pinetum* (all Poland), *Dicrano-Pinetum* (incl. *Cladonio-Pinetum* & *Leucobryo-Pinetum*; Germany, Poland, Ukraine), *Vaccinio vitis-idaeae-Pinetum* (Russia), *Quercion ilicis* (Italy).

Natura 2000 habitats: Western Taïga (code 9010, Estonia, Finland, Latvia, Norway, Sweden), Coniferous forests on, or connected to, glaciofluvial eskers (code 9060, Finland, Norway, Sweden), Caledonian forest (code 91C0, Norway), Pannonic woods with *Quercus petraea* and *Carpinus betulus* (code 91G0, Hungary, Slovakia), Western Carpathian calcicolous *Pinus sylvestris* forests (code 91Q0, Slovakia), Central European lichen Scots pine forests (code 91T0, Austria, Czech Republic, Germany, Poland, Slovakia, Ukraine), *Castanea sativa* woods (code 9260, Italy), *Quercus ilex* and *Quercus rotundifolia* forests (code 9340, Italy), Acidophilous *Picea* forests of the montane to alpine levels (*Vaccinio-Piceetea*) (code 9410, Poland, Slovakia).

Soil requirements: The fungus colonizes distinctly acid, dry to more or less fresh soils. They are always poor in nitrogen and more or less sandy (often podzol, weathered Gabbro, Italy). The litter layer is absent or thin.

Synanthropy: The species tolerates a moderate anthropogenic influence in terms of planting (also the mountain *Pinus mugo* in the lowlands).

Indicator value: The fungus is characteristic for natural and near-natural oligotrophic pine forests.

Occurrence of fruitbodies (phenology)

Basidiocarps are mainly produced from summer to late autumn (July-November), in UK already in June and still in December.

Frequency

Number of currently known sites: About 100.

Changes in frequency: The species is considered as extinct in Belgium (Fraiture & Walley 2005) and Netherlands (Arnolds 1989 and 2010, Nauta & Vellinga 1995) and as threatened a.o. in Poland (Łuszczyński (2009)). In Czech Republic, Denmark, France and Germany (Otto 1992), a decrease is reported for the last decades. In Estonia and Poland no changes have been noticed; the species seems also not to be threatened in Norway (Gulden & Hanssen 1992). In UK an increase in the number of sites is reported.

Threats and conservation

Threats: Sites are mainly threatened by eutrophication and silvicultural intensification.

Status of conservation: The species is red listed in Belgium (regional red list), Czech Republic, Estonia, France, Germany, Hungary (Lukács 2007, Kutszegi & Dima 2008), Netherlands, Poland, Switzerland and UK. It is protected by law in Estonia.

Hydnellum suaveolens (Scop.: Fr.) P. Karst.

Basidiomycota, Thelephorales, Bankeraceae

Synonyms: *Hydnum suaveolens* Scop.: Fr., *Calodon suaveolens* (Scop.: Fr.) P. Karst., *Phaeodon suaveolens* (Scop.: Fr.) J. Schröt.

Excluded: *Hydnum suaveolens* var. *caeruleum* (Hornem.) Fr., *Hydnum suaveolens* subsp. *caeruleum* (Hornem.) Sacc. [= *Hydnellum caeruleum*].

Brief description

A stipitate fungus with a hydroid hymenophore, a whitish or bluish then brownish cap, a context with horizontal blue zones and a strong smell of cumarine when dry. It mainly occurs in Boreal, Central European and Alpine domains and lives in symbiosis with coniferous trees, mostly spruce (*Picea abies*), in mountain forests. It is mostly threatened by intensification of silvicultural practices.

Geography

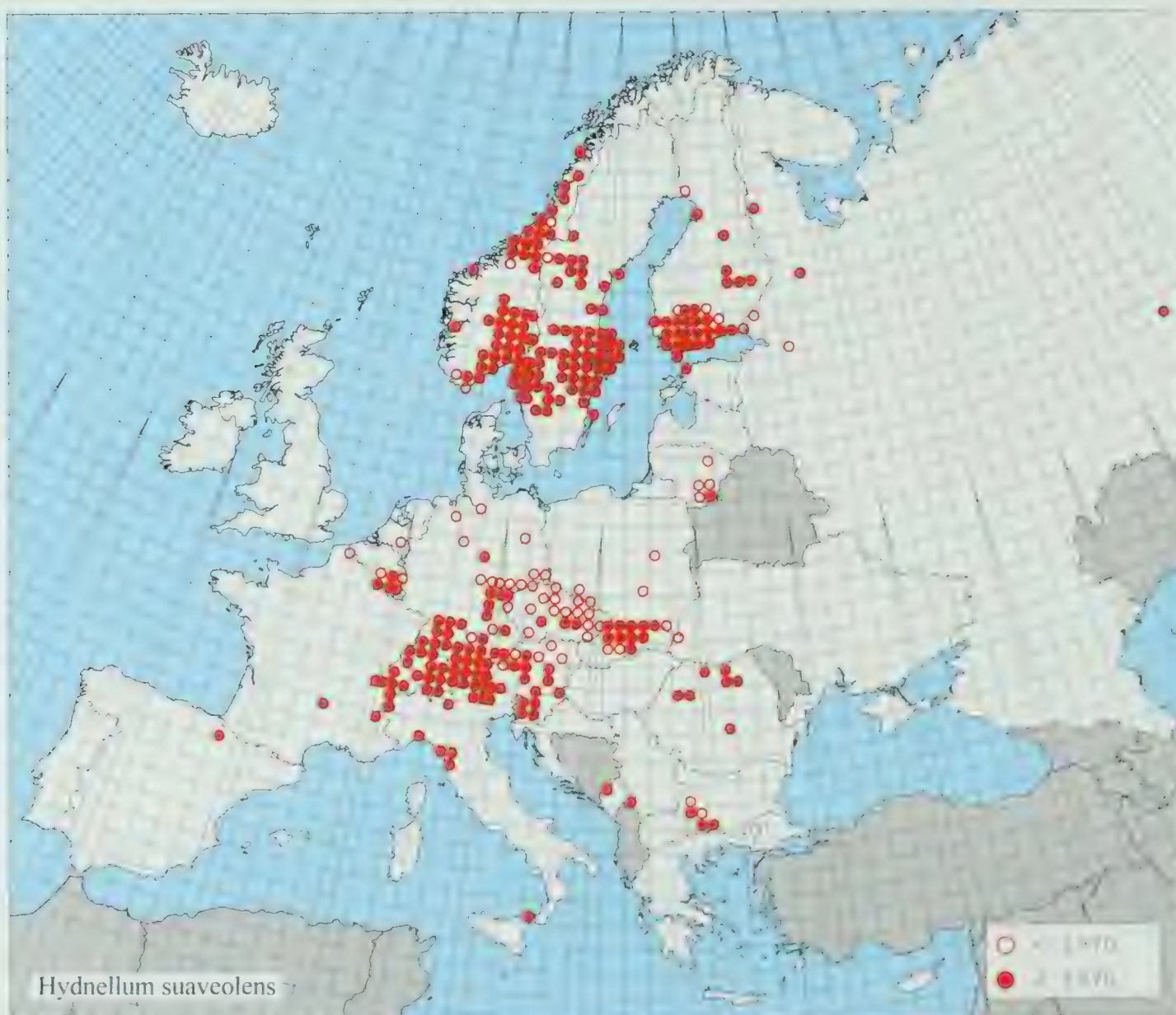
Global distribution: Europe, Asia (Siberia, China), North America (Canada, USA).

Bibliography: Coker & Beers (1951), Nikolajeva (1961), Baird (1986), Gulden & Hanssen (1992), Otto (1992), Teng (1996), Bessette et al. (1997), Arnolds (2003), Dai et al. (2004), Fraiture & Walley (2005), Hrouda (2005a), Bresinsky & Dörfelt (2008), Shiryayev (2008).



Hydnellum suaveolens

Photo Daniel Ghyselinck



Distribution of *Picea abies* coll in Europe. From *Atlas Florae Europaeae* 2 (Jalas & Suominen 1973). Courtesy of the Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo

Distribution in Europe: The species occurs from the lowlands (mainly Scandinavia) to mountainous regions (e.g. in Austria, Montenegro above 1200 m, in Italy also above 1800 m).

Besides localities indicated on the map, the species has also been mentioned from Britain and Denmark (Hroudá 2005b), without precise location. The species is also mentioned from Latvia by Otto (1992), based on a specimen collected in 1935 and preserved in herbarium JE.

The distribution of the species fits well with the area of its main host: *Picea abies* (see the map on the opposite page), except for the Sarmatic region, in which the fungus is very rare and declining.

Areal diagnosis for Europe: Mainly Bor., C-Eur. and Alp.; also in Sarm. (west); very rare in Atl. (old records), Therm. and Medit. (Italy); absent from Arct. and Step.

Trophism, hosts and substrates

The species is ectomycorrhizal and most often lives in symbiosis with *Picea abies*, occasionally also with *Abies alba* in the mountains and with *Pinus sylvestris* in more continental regions (e.g. Czech Republic, Lithuania, Romania).

Habitat

Vegetation: The fungus mainly occurs in spruce forests, in central Europe particularly in mountain spruce forests (e.g. in Estonia spruce forests of the *Oxalis acetosella* type) but only seldom in spruce plantations. Records also exist for mixed forests with beech, fir forests, subalpine larch forests and for unimproved grasslands near forest edges. See also Otto (1992).

Syntaxa of vegetation: FORESTS: *Vaccinio-Piceetum* (Germany), *Vaccinio-Piceion* (Bulgaria, Poland), *Piceetum montanum*, *Abieti-Fagetum* (both Romania), *Piceetum excelsae croaticum* (Montenegro).

Natura 2000 habitats: Western Taiga (code 9010, Estonia, Finland, Norway), Fennoscandian herb-rich forests with *Picea abies* (code 9050, Norway, Sweden), Coniferous forests on, or connected to, glaciofluvial eskers (code 9060, Finland, Latvia), Western Carpathian calcicolous *Pinus sylvestris* forests (code 91Q0, Slovakia), *Castanea sativa* woods (code 9260, Italy), Acidophilous *Picea* forests of the mountain to alpine levels (*Vaccinio-Piceetea*) (code 9410, Austria, Bulgaria, Czech Republic, Germany, Poland, Romania, Slovakia).

Soil requirements: The fungus inhabits acid, neutral and more or less basic soils (but often superficially acidified by litter decomposition) with a good water supply. Soil types: e.g. brown soil, podzol. Geologic substrate: basalt (Germany), granite, limestone, schist (Bulgaria). Nitrogen content: low to medium. Litter layer: variable.

Synanthropy: The species avoids forests strongly influenced by man.

Indicator value: The fungus is characteristic for natural and near-natural fir forests.

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from early summer to late autumn (June–November).

Frequency

Number of currently known sites: About 500 (nearly 80 % of which in Finland and Sweden).

Changes in frequency: The species is considered as extinct in the Netherlands (not observed after 1988). In Czech Republic, Germany, Lithuania, Poland and Sweden a decrease

is reported for the last 4-7 decades. A strong decline has also been observed in Belgium (Fraiture & Walley 2005). Gulden & Hanssen (1992) say “This is the most common *Hydnellum* species in Norway. There is a steady decreasing number of finds since the 1950s and a rather strong decrease in the last decade”. In Finland no changes have been noticed.

Threats and conservation

Threats: Sites are mainly threatened by silvicultural intensification.

Status of conservation: The species is red listed in Belgium (regional red list), Bulgaria, Czech Republic, France, Germany, Montenegro, Poland and Sweden.

Sarcodon fuligineoviolaceus (Kalchbr. in Fr.) Pat.

Basidiomycota, Thelephorales, Bankeraceae

Synonyms: *Hydnum fuligineoviolaceum* Kalchbr. in Fr., *Sarcodon fuligineoalbus* var. *fuligineoviolaceus* (Kalchbr. in Fr.) Quél.

Note: The species has not been published nor cited in Fries's *Systema mycologicum* and the name is therefore not sanctioned. Fries described the species in the *Hymen. Eur.*, with the mention "Kalchbr. ined."

Brief description

A medium sized to rather large stipitate hydnum, with a yellow brown to dark brown cap, a soft, reddish to violaceous flesh, without zonation, and an acrid taste. It is a rare species, mainly present in the Boreal, Central-European and Alpine domains. It forms ectomycorrhizae with various conifers, mainly *Abies alba*, *Picea abies* and *Pinus sylvestris* and lives in various kinds of biotopes, mostly on rather dry, calcareous soils, not rich in nutrients. The species is mainly threatened by silvicultural intensification (especially clear cuttings and fertilization) and by nitrogen deposition.

Geography

Global distribution: Europe, Asia (Sakhalin island, China, India, New Guinea), North America (USA).

Bibliography: Nikolajeva (1961), Maas Geesteranus (1971), Gulden & Hanssen (1992), Otto (1992), Teng (1996), Bessette et al. (1997), Pegler et al. (1997), Dai et al. (2004), Hrouda (2005a, 2005b).



Sarcodon fuligineoviolaceus

Photo Eleazar Suárez

Distribution in Europe: The species occurs from the lowlands (mainly Scandinavia) to mountainous regions (in France also above 1200 m).

The species has sometimes been mentioned from Great Britain (Jülich 1984) but it seems that it has never been confirmed (Pegler et al. 1997). The area of the fungus is included within the distribution of the hosts (*Abies alba*, *Picea abies* and *Pinus sylvestris*, see the maps on the pages 181, 192 and 105, respectively), but is much smaller (for example, the *Sarcodon* is almost absent from the temperate continental Europe).

Areal diagnosis for Europe: Mainly Bor., C-Eur. and Alp.; also Sarm. (north-west), Atl. and Medit.; absent from Arct., Therm. and Step.

Trophism, hosts and substrates

The fungus forms ectomycorrhizae exclusively with Pinaceae: *Abies alba*, *A. cephalonica* (Pantidou 1980), *Picea abies* and *Pinus sylvestris*.

Habitat

Vegetation: The biotopes colonized by the species vary considerably according to the region. In sub-Mediterranean and temperate regions the species mainly occurs in pine forests



on calcareous soils, e.g. in Estonia in alvar pine forests of the *Arctostaphylos uva-ursi* type. In the mountains, fir forests are other suitable habitats (e.g. Austria, in France in subalpine forests). In the boreal zone, forests with *Picea* are also an important biotope for the fungus. In Finland, it grows in grass-herb forests with pine and/or spruce. The occurrence in dry heaths is reported from Finland as well. In Slovenia the species was found in a natural mixed forest of pine, beech and chestnut.

Syntaxa of vegetation: FORESTS: *Erico carnea-Pinetes sylvestris*, *Fagion sylvaticae* (both France).

Natura 2000 habitats: Western Taiga (code 9010, Estonia, Finland, Sweden), Fennoscandian herb-rich forests with *Picea abies* (code 9050, Finland, Sweden), Coniferous forests on, or connected to, glaciofluvial eskers (code 9060, Sweden), *Asperulo-Fagetum* beech forests (code 9130, France), Western Carpathian calcicolous *Pinus sylvestris* forests (code 91Q0, Slovakia), Acidophilous *Picea* forests of the mountain to alpine levels (*Vaccinio-Piceetea*) (code 9410, Slovenia), Subalpine and mountain *Pinus uncinata* forests (code 9430, France).

Soil requirements: The species mainly inhabits calcareous soils (often superficially acidified), but occasionally also clearly acid ones (Finland, Slovenia). The sites are often dry, but rather wet soils are also colonized, especially in Scandinavia (podzol and rendzina). Nutrient content: low to moderate. Litter layer: repeatedly reported as thin.

Synanthropy: The fungus has never been found in strongly anthropogenic biotopes.

Indicator value: The species is characteristic for natural and near-natural habitats (mainly forests, seldom heaths).

Occurrence of fruitbodies (phenology)

Basidiocarps are produced from summer to autumn (August-November).

Frequency

Number of currently known sites: About 50 (nearly 50 % of which in Spain and Sweden).

Changes in frequency: In Austria there is no record after 1975. In France a decrease is reported for the last 2 decades, in Germany and Sweden for a period of about 100 years.

Threats and conservation

Threats: Sites are mainly threatened by silvicultural intensification (especially clear felling and fertilization) and by eutrophication due to nitrogen deposition from air pollution.

Status of conservation: The species is red listed in Belgium (regional red list), Finland, France, Germany, Iberian Peninsula (Spain + Portugal), Norway, Slovakia, Sweden and Switzerland. The species is included in the IUCN *Global Fungal Red List Initiative* (see their web-site). See also Dahlberg & Croneborg (2003, 2006).

Hericium erinaceus (Bull.: Fr.) Pers.

Basidiomycota, Russulales, Hericiaceae

Note 1: *Erinaceus* is the common Latin name for hedgehog (Plinius). It must then be treated as a noun in apposition and retains its own gender and termination, irrespective of the gender of the generic name (Art. 23.5).

Note 2: The f. *caput-medusae* (Bull.: Fr.) Nikol. differs from f. *erinaceus* in having a branched sporophore.

Note 3: The species is cultivated as a medicinal mushroom, a.o. in Europe. The cultivation leads to an increase of sites in gardens. Furthermore, a genetic introgression between the cultivated strains and the native populations is to be assumed.

Brief description

A large whitish hydroid fungus, composed of a round (f. *erinaceus*) or branched (f. *caput-medusae*) stem covered by a great amount of 2-5 cm long spines directed downwards. The species is rather widely distributed in Europe except in the Boreal, Sarmatic and Step-pic domains. It lives as a necrotrophic parasite or as a saprotroph, mainly on old individuals of beech (*Fagus sylvatica*) and of different species of oaks (*Quercus*), in forests and plantations. It is threatened by the intensification of forestry practices, mainly by felling of old trees.

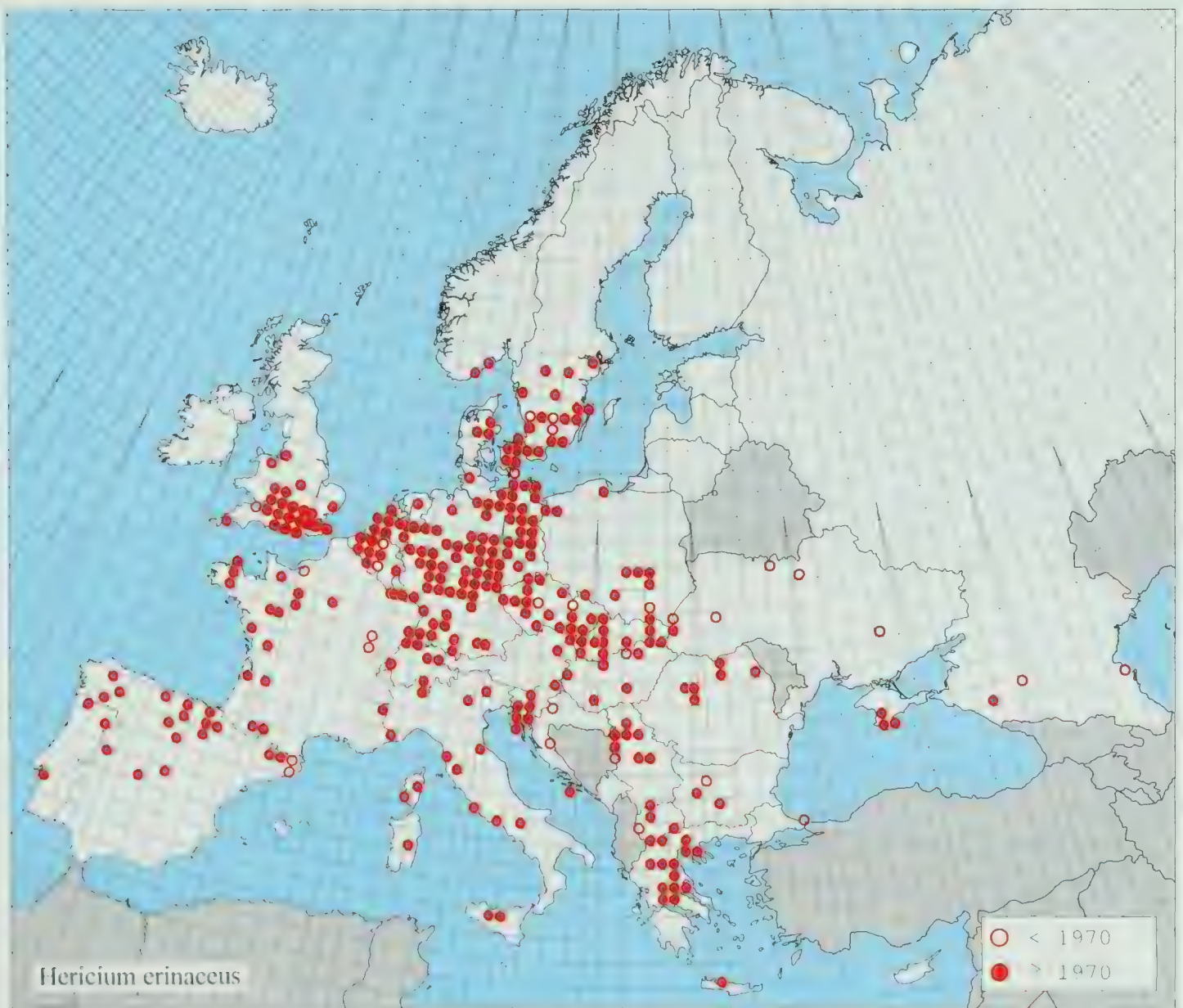
Geography

Global distribution: Europe, Asia (Siberia, Armenia, Georgia, Turkey, India, Nepal, Pakistan, Mongolia, China, North Korea, Japan, Borneo), North America (USA), Oceania (Australia).



Hericium erinaceus

Photo: Jacques Ghesmard



Bibliography: Coker & Beers (1951), Butler & Bisby (1960), Nikolajeva (1961), Maas Geesteranus (1971), Harrison (1973), Tortić & Jelić (1977), Doll (1979), Tellería (1980), Knudsen & Pedersen (1984), Ginns (1985), Koski-Kotiranta & Niemelä (1987), Arnolds et al. (1995), Teng (1996), Pegler et al. (1997), Gyosheva (2000), Mao (2000), Arnolds (2003), May et al. (2003), Dai et al. (2004), Wojewoda et al. (2004), Fraiture & Walley (2005), Piątek (2005c), Siller et al. (2005), Bresinsky & Dörfelt (2008), Sesli & Denchev (2008), Alexov et al. (2012), Gvritishvili et al. (2012).

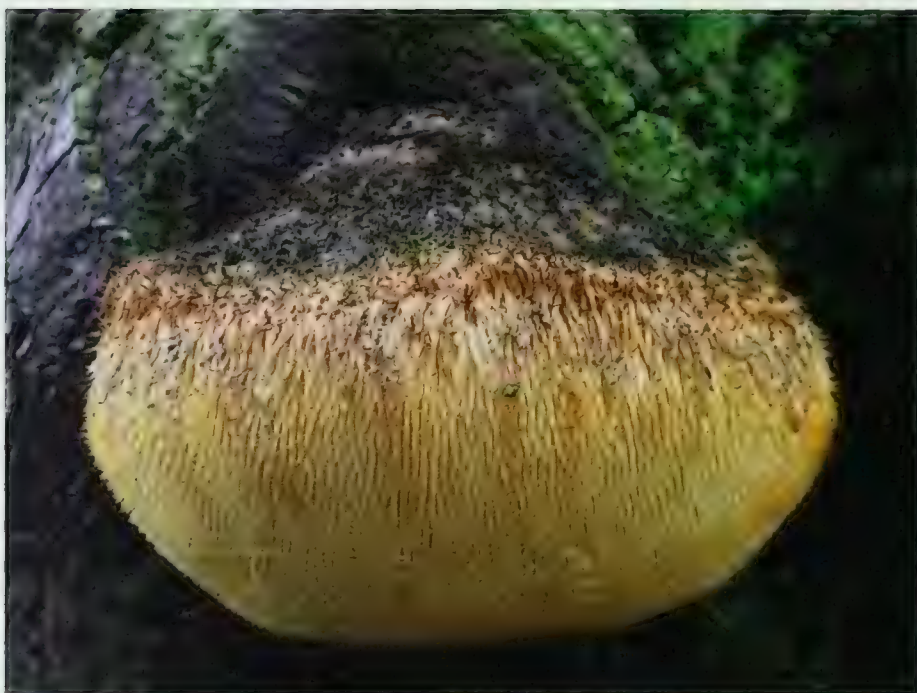
Distribution in Europe: The species mainly occurs in the lowlands, only seldom in mountainous regions (e.g. Greece, Macedonia, in Italy up to 1500 m).

Besides localities indicated on the map, the species is probably also present in Bosnia (Tortić & Jelić 1977). Its distribution fits well with the distribution of its main host, *Fagus sylvatica* (see the maps on p. 22).

Areal diagnosis for Europe: Mainly present in Atl. and C-Eur.; also present in Sarm., Alp., Therm. and Medit.; one old mention in Step. (Ukraine); absent from Arct. and Bor.

Trophism, hosts and substrates

Primarily, the species lives as a necrotrophic parasite on living old deciduous and sclerophyllous trees. It invades the trunks and thick branches through lesions and produces a white rot. After the death of the trees the fungus is able to continue its growth for many



Hericium erinaceus.
Photo Dominique Schott

years and to produce fruitbodies also on lying trunks and stumps. Mainly *Fagus sylvatica* and *Quercus* spp. (*cerris*, *frainetto*, *gussonei*, *ilex*, *petraea*, *pubescens*, *robur*) are colonized, seldom also *Aesculus hippocastanum* (Germany), *Albizia julibrissin* (Greece), *Alnus glutinosa* (Ukraine), *A. incana* (Romania), *Carpinus betulus* (Germany), *Populus tremula* (Ukraine) and *Tilia cordata* (Germany). Other occasional hosts are cited by Knudsen & Pedersen (1984), Tortić & Jelić (1977), Doll (1979) and Fraiture & Walley (2005): *Betula*, *Juglans*, *Malus*, *Ailanthus* and *Sorbus*. A characteristic associated fungus is *Creolophus cirrhatus*.

Habitat

Vegetation: The fungus mainly occurs in deciduous and sclerophyllous forests, most often in beech and oak forests, but also in oak plantations, semi-open forests, maple ash forests and coniferous plantations with deciduous trees. There are some records for habitats influenced by man (especially road sides and parks, e.g. Denmark, Greece, Spain, Ukraine). In the Netherlands the fungus was exclusively found in such anthropogenic habitats. In Germany there is even a record on wood in a mine.

Syntaxa of vegetation: FORESTS: *Galio odorati-Fagenion*, *Galio odorati-Fagetum*, *Hordelymo-Fagetum*, *Carici-Fagetum*, *Luzulo-Fagenion*, *Potentillo albae-Quercetum petraeae* (all Germany), *Luzulo-Fagetum* (Germany, Poland), *Fagetum carpaticum* (Poland), *Melittio-Fagetum* (Hungary), *Quercio-Fagetum* probably except *Quercetalia pubescenti-sessiliflorae* (France), *Carpino-Fagetum*, *Carpino-Quercetum* (both Romania), *Fagion sylvaticae*, *Quercetum cerridis* (both Bulgaria), *Quercetum frainetto-cerris*, *Festuco heterophyllae-Fagetum* (both Macedonia).

Natura 2000 habitats: Fennoscandian hemiboreal natural old broad-leaved deciduous forests (*Quercus*–*Tilia*–*Acer*, *Fraxinus* or *Ulmus*) rich in epiphytes (code 9020, Sweden), Fennoscandian wooded pastures (code 9070, Sweden), *Luzulo-Fagetum* beech forests (code 9110, Austria, Czech Republic, Denmark, France, Germany, Luxembourg, Poland, Slovakia, Sweden), Atlantic acidophilous beech forests with *Ilex* and sometimes also *Taxus* in the shrublayer (code 9120, France, Germany, Netherlands, Spain, UK), *Asperulo-Fagetum* beech forests (code 9130, Czech Republic, Denmark, France, Germany, Poland, Spain, Sweden, UK), Medio-European subalpine beech woods with *Acer* and *Rumex arifolius* (9140, Czech Republic, France, Romania), Medio-European limestone beech forests of the *Cephalanthero-Fagion* (code 9150, Denmark, France, Germany), Sub-Atlantic and Medio-European oak or oak-hornbeam forests of the *Carpinion betuli* (code 9160, Croatia,

France, Germany, Slovenia, Sweden, Switzerland, UK), *Galio-Carpinetum* oak-hornbeam forests (code 9170, Austria, Bulgaria, France, Slovakia), *Tilio-Acerion* forests of slopes, screes and ravines (code 9180, UK), Old acidophilous oak woods with *Quercus robur* on sandy plains (code 9190, France, Slovakia), Pannonic woods with *Quercus petraea* and *Carpinus betulus* (code 91G0, Croatia, Slovakia), Eastern white oak woods (code 91AA, Bulgaria, Macedonia), Galicio-Portuguese oak woods with *Quercus robur* and *Quercus pyrenaica* (code 9230, Portugal), *Quercus faginea* and *Quercus canariensis* Iberian woods (code 9240, Portugal, Spain), *Quercus suber* forests (code 9330, Spain), *Quercus ilex* and *Quercus rotundifolia* forests (code 9340, Italy, Spain).

Soil requirements: A wide range of soil types and characteristics has been reported but, since the species is lignicolous, these variations should be of little importance.

Synanthropy: The species is mainly restricted to natural and near-natural forests (rather seldom at road sides and in parks).

Indicator value: The species is a rather good indicator for old-growth beech and oak forests.

Occurrence of fruitbodies (phenology)

Basidiocarps are mainly produced from early summer till late autumn (August-November), in UK even till December-January, in Greece also from March till May.

Frequency

Number of currently known sites: About 350.

Changes in frequency: In Romania there is no record after 1975. In Denmark a decrease has been noticed for the last 100 years, in France, Greece, Hungary and Sweden for the last decades. In Czech Republic no changes were reported. In UK an increase in the number of sites is mentioned.

Threats and conservation

Threats: Sites are mainly threatened by silvicultural intensification, mainly by felling of old trees.

Status of conservation: The species is red listed in Austria, Belgium (regional red list), Bulgaria, Czech Republic, Denmark, France, Germany, Hungary, Iberian Peninsula (Spain + Portugal), Luxembourg, Macedonia, Netherlands, Poland, Russia (regional red list), Serbia, Slovakia, Sweden, Switzerland and UK. It is protected by law in Croatia, Hungary, Poland, Serbia, Slovenia and UK. See also Dahlberg & Croneborg (2003, 2006).

Sarcosoma globosum (Schmidel: Fr.) Casp.
Ascomycota, Pezizales, Sarcosomataceae

Note: The combination by Caspary has been published in Rehm, *Rabenh. Krypt.-Fl.* 13 (3): 497 (1891). Rehm writes Casp. “in litt.”

Brief description

A remarkable cup fungus, with brown, quite large and heavy globose ascocarps, with a very thick gelatinised and watery excipulum and a dark brown hymenium. It has been almost exclusively found in Boreal, Sarmatic and Central-European domains but it is almost extinct outside Scandinavia and the three Baltic states. It is always associated with spruce (*Picea abies*) although its ectomycorrhizal character remains to be proven. Ascocarps are mainly produced in spring and early summer. The species grows in old undisturbed forests and is especially threatened by the rarefaction of this type of habitat.

Geography

Global distribution: Europe, Asia (Armenia, Georgia, Siberia), Africa (Cameroon), North America (USA, Canada).

Bibliography: Seaver (1942), Paden & Tylutki (1969), Martinsson & Nitare (1986), Bessette et al. (1997), Ronikier (2005d), Gvritishvili et al. (2012).



Sarcosoma globosum

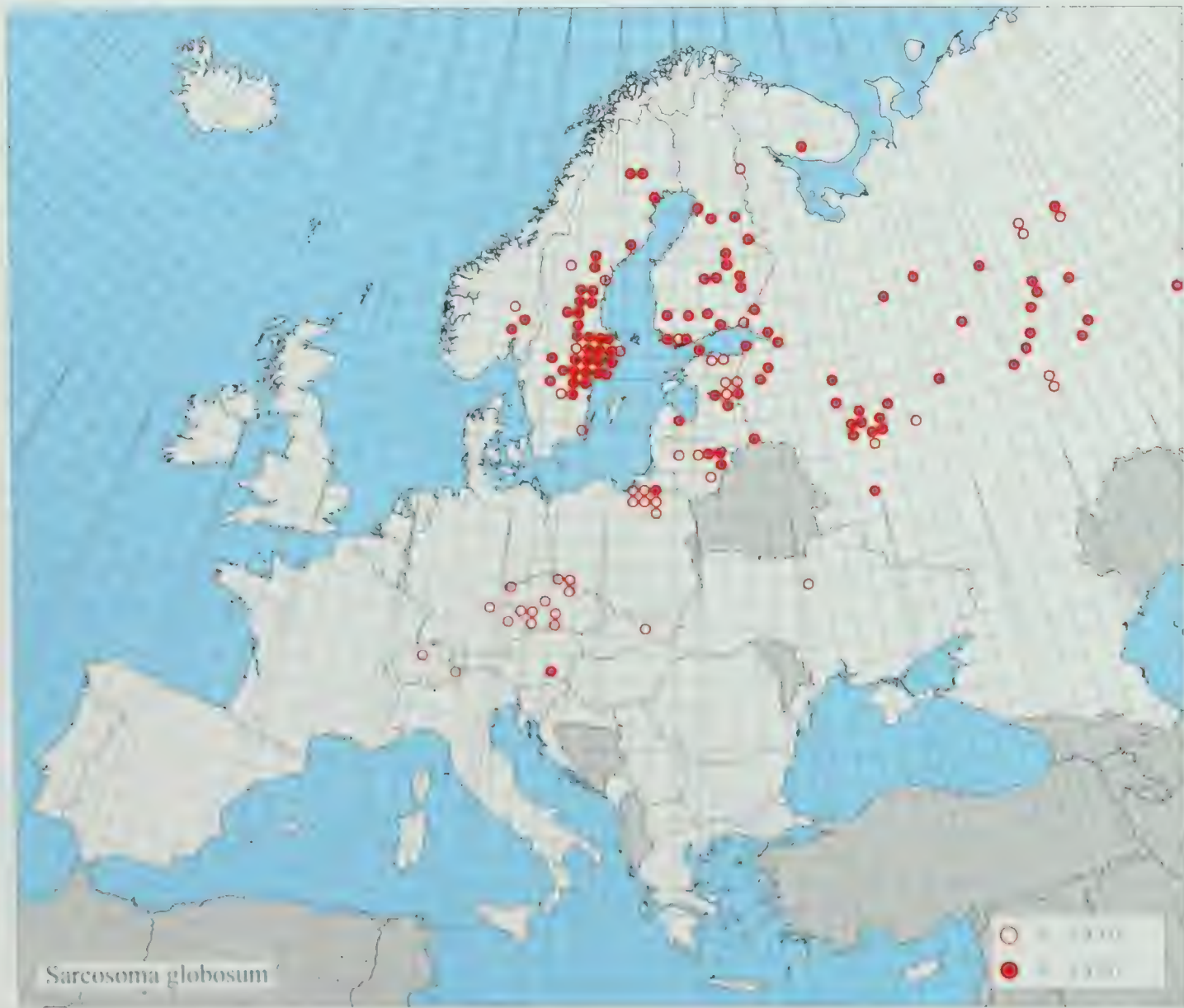
Photo Bellis Kullman

Distribution in Europe: In Scandinavia the species occurs in the lowlands; in central Europe it grows almost exclusively in the mountains. In European Russia, it is confined to hemiboreal zone and southern taiga.

Lange (1974) already pointed out that the species seems to have two areas of distribution. The first one is located in Scandinavia, mostly in Sweden (Stockholm area), but there are also scattered observations in Norway and Finland. The second area is centred on Czech Republic, with extensions in Poland, eastern Germany and Austria. The map presented here is more complete but confirms the splitting of the distribution in two areas: one in northern Europe (Scandinavia, Russia, the three Baltic states and NE Poland) and another one in the mountainous regions of central Europe (Switzerland, SE Germany, Czech Republic, SW Poland, Slovakia and Austria).

Cittadini & Lunghini (2006) describe as *Sarcosoma globosum* a collection made in Rome (Italy). However, these specimens must be reported to *Urnula mediterranea* (= *Plectania mediterranea*), a species subsequently described (Carbone et al. 2009, 2013).

Areal diagnosis for Europe: Almost exclusively in Bor., Sarm. (many old records) and CEur. (south [only old records] and north); very rare in Alp. (mostly old records); absent from Arct., Atl., Therm., Medit. and Step.



Trophism, hosts and substrates

The species is probably a humicolous saprotrophic species. It is always associated with *Picea abies* and often colonizes mossy needle litter (in Lithuania also recorded on decayed wood among mosses). The close association with *Picea* could be a reason to assume an ectomycorrhizal nutrition strategy, but the frequent growth on thick litter layers and the limitation to old trees are untypical for this. Lange (1974) also mentions *Pinus* as occasionally associated with the species.

Habitat

Vegetation: The fungus almost exclusively occurs in old spruce forests (*Picea abies*) and in mixed forests with spruce. In Estonia moss-rich stands are inhabited, in Sweden also wooded pastures with spruce and in Finland (Ohenoja et al. 2013) also river banks with old spruces. In Lithuania, some herbaceous plants (*Carex digitata*, *Hepatica nobilis*, *Luzula pilosa*, *Oxalis acetosella* and *Vaccinium myrtillus*) and mosses (*Hylocomium splendens*, *Plagiomnium affine*, *Pleurozium schreberi*, *Rhodobryum roseum*) were presents on nearly all the growthplaces of the species (Kutorga et al. 2014). See also Martinsson & Nitare (1986).

Syntaxa of vegetation: FORESTS: *Piceion excelsae* (Germany, Slovakia).

Natura 2000 habitats: Western Taïga (code 9010, Estonia, Finland, Latvia, Lithuania, Sweden), Fennoscandian herb-rich forests with *Picea abies* (code 9050, Finland, Lithuania, Sweden), Fennoscandian wooded pastures (code 9070, Sweden), Acidophilous *Picea* forests of the mountain to alpine levels (*Vaccinio-Piceetea*) (code 9410, Czech Republic, Germany).

Soil requirements: The species mainly inhabits distinctly acid and well water supplied soils, only in Finland rather dry soils are reported. Nitrogen content: often clearly low; in Estonia findings in mesotrophic sites have been reported. Soils are sandy to silty, the only recorded type is podzol. Litter layer: always present and repeatedly recorded as thick.

Synanthropy: This anthropophobic fungus mainly colonizes natural and near-natural biotopes (most often forests, seldom wooded pastures).

Indicator value: The species is rather stenoeccious and mainly restricted to old undisturbed spruce forests. Parmasto (2001b) lists it among the fungi indicators of primeval and old-growth forests deserving protection.

Occurrence of fruitbodies (phenology)

Ascocarps are mainly produced in spring and early summer (March-June). In Czech Republic, Finland, Lithuania and Sweden, they have also been found in December; in Poland, at the end of November and in July.

Frequency

Number of currently known sites: About 150 (nearly 80 % of which in Sweden).

Changes in frequency: With the exception of an observation in Austria, all the mentions from central Europe are ancient. In Czech Republic, Lithuania and Slovakia a decrease is reported for the last 4-5 decades, in Germany and Sweden for the last 100 years. In Germany, all the mentions date from before 1970. In Slovakia there is no record after 1967 and in Czech Republic after 1966 when, fide Kavina (1929), the species was rather frequent (more than 10 localities) in the old *Picea* forests of southern Bohemia. In Poland, no record

is mentioned after 1923 although, fide Ronikier (2005d), the species was not rare in NE Poland one century ago. In contrast, an increase of sites is reported for the last decades in Finland (Ohenoja et al. 2013), Lithuania (Kutorgas et al. 2014) and Latvia. In Russia an increase of sites is also reported for the last 5 years, especially in the Moscow Region and in the Vyatka-Kama interfluvium. Now ca. 40 localities are known in European Russia (more than 30 reported after 2005).

Zettur & Kullman (2011) report that, in Estonia in 2005, after a winter during which the ground was not frozen deep and was covered with a thick layer of snow, a large number (altogether ca 3300 in the country) of fruit-bodies of *Sarcosoma globosum* – a species that seemed earlier to be disappearing in the country – appeared, mostly in the same places where they had been found decades earlier. In the following years many new localities of *S. globosum* were found in the country.

Threats and conservation

Threats: The species is mainly threatened by deforestation of old-growth forest habitats in consequence of silvicultural intensification (see also Martinsson & Nitare 1986). Forest floor disturbance (e.g. by wild boar) has also a negative effect (Kutorga et al. 2014).

Status of conservation: The species is red listed in Czech Republic, Estonia, Finland, Germany, Latvia, Lithuania, Norway, Poland, Russia, Slovakia and Sweden. The fungus is protected by law in Lithuania and Slovakia. The species is included in the IUCN *Global Fungal Red List Initiative* (see their web-site). See also Dahlberg & Croneborg (2003, 2006).

Sarcosphaera coronaria (Jacq.: Fr.) J. Schröt.

Ascomycota, Pezizales, Pezizaceae

Synonyms: *Sarcosphaera crassa* (Santi ex Steud.) Pouzar, *S. eximia* (Durieu & Lév.) Maire, *S. dargelatii* (Gachet) Nannf., *Peziza coronaria* Jacq., *Sarcoscypha macrocalyx* (ss. auct. Brit.?)

Note 1: Fries cites *Peziza coronaria* Jacquin in the second volume of the *Systema mycologicum* (1821: 50), sub "*Peziza coronata*", but the bibliographical reference to the protolog is correct. Therefore, this name can be considered as sanctioned and must be used as the basionym, even if *Peziza crassa* Santi is older (Pouzar 1972).

Note 2: J. Schröter (in F. Cohn) published the combination in the genus *Sarcosphaera* in *Die Pilze Schlesiens* II: 49. That work has been finished in 1908 but, after the TL-2 (vol. 1: 520), the fascicle containing the combination has been published in 1893. This combination is thus older than the one made by Boudier in *Icones mycologicae* (1904 for the "Liste préliminaire" and 1907 for the text of the pl. 296). Richard Korf, in the comments added to the reprint of Boudier's work (p. 221) also cites Schröter as the author of the combination. The citation by Boudier in *Bull. trim. Soc. mycol. France* 1: 101 (1885) is not a valid combination.

Note 3: A var. *nivea* (M.M. Moser) Péricouche & Courtec. has been described. See Schäfer (1984), Cetto (1993: pl. 2090) and Péricouche & Courtecuisse (2001).

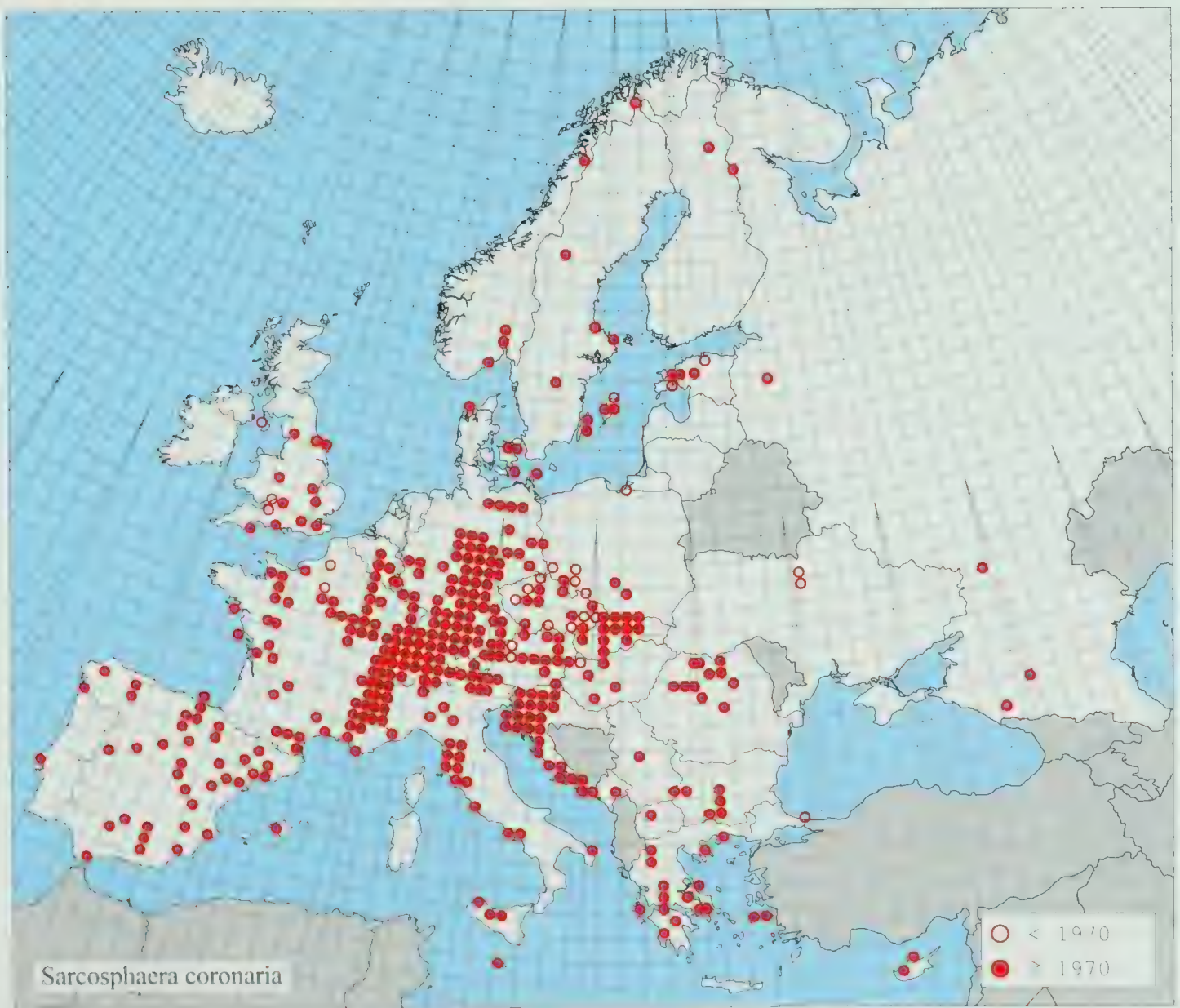
Brief description

A striking cup-fungus, producing large apothecia which are first globose and hypogeous, with a whitish excipulum, and then open by forming conical lobes to expose the violaceous hymenium. It has a large distribution in Europe but is mainly present in the Central-European and Alpine domains. It is a toxic species, appearing in spring and, occasionally, at other periods of the year, according to the region. It can grow on litter and humus as a saprotroph in a wide range of habitats, but could perhaps also produce mycorrhizae.



Sarcosphaera coronaria

Photo Yves Denev



Geography

Global distribution: Europe, Asia (Turkey, Israel, China), Africa (Algeria), North America (Canada, USA, Mexico).

Bibliography: Seaver (1942), Buschmann (1958), Gumińska (1968), Brandrud et al. (1986), Teng (1996), Mao (2000), Medel & Calonge (2004), Fraiture & Walley (2005), Ronikier (2005e), Lizoň & Zelený (2006), Medel et al. (2006), Zhuang & Yang (2007), Bresinsky & Dörfelt (2008), Sesli & Denchev (2008).

Distribution in Europe: The fungus occurs from the lowlands to the subalpine zone (e.g. in Macedonia exclusively between 1900 and 2000 m, in Poland mainly in the subalpine zone).

Areal diagnosis for Europe: Mainly C-Eur. and Alp.; also Atl., Therm. and Medit.; very rare in Bor. and Sarm.; absent from Arct. and Step.

Trophism, hosts and substrates

The mode of nutrition is not clarified yet. If it is certain that the species is able to decompose organic matter (at least by cellulases), it is only supposed and not proven that it forms ectomycorrhizae (possibly only facultatively). Fruitbodies were found on humus, among leaf and needle litter, and also on decayed woody substrates (e.g. in Estonia; in this case the fungus is even weakly lignicolous).

Habitat

Vegetation: The fungus occurs in a wide range of habitats and can grow in forests and plantations, in coppices up to the subalpine level, as well as in open grassy biotopes. Records exist e.g. in pine and spruce forests (e.g. Belgium, France, Russia, Slovenia), in plantations of *Pinus nigra* and/or *P. halepensis* (Croatia, Malta, Montenegro), in mixed forests a.o. alvar forests (Estonia), *Acer*, *Fraxinus*, *Pinus* (Hungary), *Abies nordmanniana*, *Fagus orientalis* (Russia: Adygea), in a remarkably wide range of deciduous forests, as well as in sclerophyllous forests, scrublands, grey costal dunes and dry grasslands (both Germany). The species is considered as related to the *Boletus aerei-Russuletum luteotactae* (Czech Republic).

Not seldom the fungus occurs in biotopes strongly influenced by man: parks (e.g. Serbia), gardens, vineyards (Germany), roadsides (Denmark), mining deposits and old fire sites (both Germany). See also Buschmann (1958), Gumińska (1968), Schäfer (1984), Brandrud et al. 1986, Dörfelt (1986), Adameczyk (1996), Fraiture & Walley (2005), Bresinsky & Dörfelt (2008).

Syntaxa of vegetation: FORESTS: calcareous *Dicrano-Pinion* (Finland), *Galio odorati-Fagetum*, *Hordelymo-Fagetum*, *Abieti-Fagetum*, *Lonicero alpigenae-Fagetum*, *Seslerio-Fagetum*, *Carpinion betuli* (all Germany), *Dentario glandulosae-Fagetum*, *Quercus robur-Pinetum*, *Plagiothecio-Piceetum tatricum* (all Poland), *Cephalanthero-Fagenion*, *Carici-Fagetum*, *Dentario enneaphylli-Fagetum* (all Germany and Poland), *Fagion sylvaticae*, *Erica carnea-Pinetea sylvestris*, *Oleo sylvestris-Ceratonion siliquae*, *Rhamno lycioidis-Quercion cocciferae* (all France), *Soldanello majori-Picenion* (Romania), *Pinion sylvestris*, *Vaccinio-Piceion*, *Fagion sylvaticae* (all Bulgaria), *Abieti-Fagetum macedonicum* (Macedonia), *Fagetum subalpinum* (Montenegro), *Quercion ilicis* (Italy); SHRUBS: *Erica-Rhododendretum hirsuti*, *Rosa-Juniperetum*, *Viburno-Cornetum* (all Germany), GRASSLANDS: *Gentiano-Koelerietum*, *Mesobromion erecti* (both Germany).

Natura 2000 habitats: *Juniperus communis* formations on heaths or calcareous grasslands (code 5130, Estonia, Slovakia), Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (code 6210, Germany, Slovakia), Western Taiga (code 9010, Finland, Sweden), Coniferous forests on, or connected to, glaciofluvial eskers (code 9060, Finland), Fennoscandian wooded pastures (code 9070, Sweden), *Asperulo-Fagetum* beech forests (code 9130, Austria, France, Germany, Poland, Slovakia, UK), Medio-European limestone beech forests of the *Cephalanthero-Fagion* (code 9150, Denmark, Germany, Poland, Slovakia, Sweden, Switzerland), *Tilio-Acerion* forests of slopes, screes and ravines (code 9180, Germany, Slovakia), Western Carpathian calcicolous *Pinus sylvestris* forests (code 91Q0, Slovakia), Eastern white oak woods (code 91AA, Macedonia), *Castanea sativa* woods (code 9260, Italy), Hellenic beech forests with *Abies borisii-regis* (code 9270, Macedonia), *Quercus ilex* and *Quercus rotundifolia* forests (code 9340, Italy), Acidophilous *Picea* forests of the mountain to alpine levels (*Vaccinio-Piceetea*) (code 9410, Bulgaria, Czech Republic, Macedonia, Poland, Romania, Slovakia, Sweden, Switzerland), Alpine *Larix decidua* and/or *Pinus cembra* forests (code 9420, Austria, Slovakia), (Sub-)Mediterranean pine forests with endemic black pines (code 9530, Croatia, France), *Quercus ilex* and *Quercus rotundifolia* forests (code 9340, Italy, Malta).

Soil requirements: Most records originate from more or less basic and rather dry to fresh soils, but acid soils are also colonized (e.g. Hungary, Spain). Soil types: brown soil, leptosol (Poland), loess (Czech Republic), pararendzina, rendzina, podzol (e.g. Macedonia), brown coal-rich soil (Germany). Geologic substrate: often limestone, seldom granite (Germany). Nitrogen content: low to moderate. Grain size: from gravel to clay. Litter layer: always present, often thick.

Synanthropy: The rather euryoecious fungus occurs in natural (forests), semi-natural (e.g. grasslands) and strongly anthropogenic biotopes (e.g. gardens, vineyards).

Indicator value: The species cannot be used as an indicator of specific habitats. Only the preference for more or less basic soils is to be mentioned.

Occurrence of fruitbodies (phenology)

Ascocarps are mainly produced in two periods, often in spring (April-May) and occasionally in autumn (September-October). In Croatia and France they can appear already in February, in Spain still in December, in northern regions (Estonia, Finland) and in high mountain (Macedonia, Poland, Romania) mainly during the summer months (June-August). The year following a year of abundant occurrence, only a few fruitbodies or even none might be found at the same locality (Ronikier 2005e).

Frequency

Number of currently known sites: About 700.

Changes in frequency: For Czech Republic, Estonia, France and Sweden a decrease is reported for the last 5 decades. In Austria, Croatia, Greece, Poland and Spain no changes have been noticed. In UK an increase in the number of sites is reported for the last decades. In Russia the species was reported for the first time in 2004; today 4 sites are known (Novgorod, Rostov and Stavropol regions, Adygea).

Threats and conservation

Threats: The sites are mainly threatened by severe damages of the habitats (first of all clear felling of woodlands).

Status of conservation: The species is red listed in Austria, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France (regional red list), Germany, Hungary, Malta, Norway, Poland, Russia (regional red list), Slovakia, Spain, Sweden and UK. The fungus is protected by law in Estonia, Malta, Serbia and Slovakia. See also Dahlberg & Croneborg (2003, 2006).

Helvella atra J. König: Fr. ss. Holmsk.

Ascomycota, Pezizales, Helvellaceae

Synonym: *Leptopodia atra* (J. König: Fr.) Boud.

Excluded: *Helvella atra* J. König ss. Oeder and ss. König

Note 1: The systematics of this taxon is complicated (see also Dissing 1964 and Filippa & Baiano 2011). There are two different *Helvella atra*:

1) *Helvella atra* has been described by J. König, in *Flora Islandica* (1772: 20), who also published a plate in Oeder, *Flora Danica* (1770: pl. 534). After Dissing (1964) and Häffner (1987), that description and that illustration actually represent the small arctic form of *H. lacunosa*.

2) Later on, the name published by König has been used by Holmskjöld, in *Beata raris otia Fungis Danicis impensa* 2: 47, tab. 25 (1799), who also gives an excellent illustration. However, the description and the plate proposed by this author are not corresponding with the fungus described by König, but rather with our actual conception of *Helvella atra*. The Holmskjöld figure has been designated, by Dissing (1966: 121), as the lectotypus of the species.

In the *Systema mycologicum* 2: 19, Fries cites, under *H. atra*, either König, Fl. Isl. and Fl. Dan., and Holmskjöld. So, he doesn't make a distinction between the two taxa. He also cites *H. nigricans* Pers. as a synonym.

In conclusion, our taxon is *H. atra* König in Oeder: Fr. ss. Holmskj., non ss. Oeder nor ss. König, and it is probably necessary to give it a new name.

Note 2: According to the Finish report, *H. atra* is not clearly separated from *H. subglabra* and *H. pezizoides*.

Note 3: A f. *minima* and a f. *maxima* have been described (Häffner 1987).



Helvelliatra

Photo Yves Danciger

Brief description

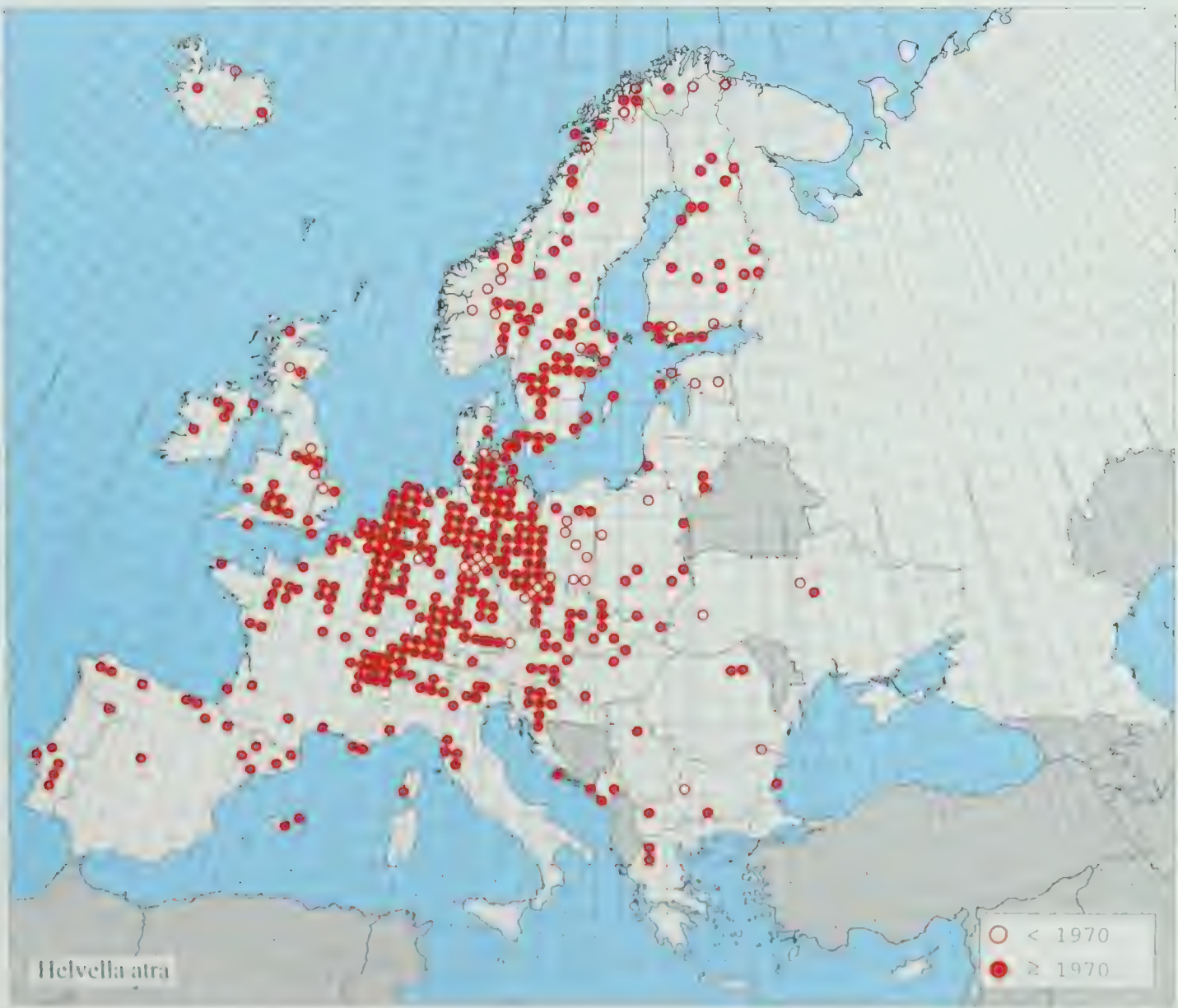
A pubescent helvella, with a blackish saddle-shaped apothecia, supported by a solid grey stem. It is mainly present in the Central-European, Atlantic and Alpine domains. It lives as a terricolous saprotroph in a wide range of habitats, either natural or anthropogenic (parks and cemeteries).

Geography

Global distribution: Europe, Asia (Armenia, Georgia, Turkey, Israel, Kazakhstan, Pakistan, India, Tibet, China, Taiwan), Africa (Algeria), North America (USA, Mexico), Central America (Costa Rica, Jamaica). Fide Barseghyan & Wasser (2008), also in South America.

Bibliography: Denison (1963), Dissing (1964, 1966), Gómez-Pignataro (1974), Abbott & Currah (1988), Mao (2000), Medel & Calonge (2004), Zhuang (2004), Fraiture & Walley (2005), Vite-Garín et al. (2006), Bresinsky & Dörfelt (2008), Sesli & Denchev (2008).

Distribution in Europe: The species mainly occurs in the lowlands, only occasionally in mountainous regions (e.g. in Macedonia, Slovenia and Spain up to 1200 m, Bulgaria and Switzerland also above this altitude).





Helvella atra

Photo Daniel Ghyselinck

Areal diagnosis for Europe: Mainly Atl., C-Eur. and Alp.; also Aret., Bor., Sarm. (west), Therm. and Medit.; absent from Step.

Trophism, hosts and substrates

The fungus is a terricolous saprotroph, decaying humus particles often on mossy places. It has been very rarely found on strong decayed woody material (e.g. wood shreds).

Habitat

Vegetation: The fungus inhabits a very wide range of habitats, forests and plantations as well as different kinds of more or less open biotopes. Deciduous forests are the most suitable for the species (e.g. beech, oak and alder forests, alluvial forests), but mixed and coniferous forests are also colonized, e.g. forests on dunes (France), mixed forest with *Populus nigra* and *Juniperus communis* in Serbia, *Abies* plantations on calcareous soils (Denmark), *Pinus* forests, mountain *Abies-Fagus* forests, evergreen Mediterranean forests (the last two Croatia). The occurrence of the fungus in bushes, shrublands, grassy heathlands (Iceland), maechia (Italy) and grasslands (including lawns) has also been observed. The species has also rather often been found in anthropogenic habitats, such as recultivated coal mining dumps (e.g. Czech Republic), old lime/clay pits (Denmark), road sides, ruderal sites (Finland), cemeteries, gardens, parks (e.g. Lithuania, in Montenegro also with *Cupressus*) and fire places (Belgium). See also Bresinsky & Dörfelt (2008).

Syntaxa of vegetation: FORESTS: *Carpinion betuli*, *Galio sylvatici-Carpinetum*, *Fagion sylvaticae*, *Hordelymo-Fagetum*, *Carici-Fagetum*, *Betulo-Quercetum petraeae*, *Pruno-Fraxinetum*, *Ulmenion minoris*, *Quercio-Ulmetum minoris* (all Germany), *Tilio cordatae-Carpinetum betuli*, *Stellario holostae-Carpinetum betuli*, *Galio odorati-Fagetum* (all Poland), *Betulo-Adenostyletea* (Switzerland), *Carici pilosae-Carpinetum*, *Asperulo-Fagetum* (both Hungary), *Symphyto cordati-Fagetum* (Romania), *Tilio-Fraxinetum*, *Vaccinio-Piceetum* (both Bulgaria); SHRUBS: *Salicetum cinereae* (Germany), *Salicion waldsteinianae* (Switzerland), *Quercio-Castanetum submediterraneum*, *Seslerio-Ostryetum carpinifolia*, *Fagion moesiaca*, *Fagetum submontanum* (all Montenegro).

Natura 2000 habitats: Wooded dunes of the Atlantic, Continental and Boreal region (code 2180, Netherlands), Western Taïga (code 9010, Estonia), *Asperulo-Fagetum* beech forests (code 9130, Hungary, Poland), Medio-European limestone beech forests of the *Cephalanthero-Fagion* (code 9150, Denmark, Germany, Slovakia), Sub-Atlantic and medio-European oak or oak-hornbeam forests of the *Carpinion betuli* (code 9160, Croatia, Poland, Slovakia), *Galio-Carpinetum* oak-hornbeam forests (code 9170, Germany, Poland, Slovakia), Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*) (code 91E0, Germany, Netherlands), Riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *Ulmus minor*, *Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*) (code 91F0, Germany), Pannonic woods with *Quercus petraea* and *Carpinus betulus* (code 91G0, Croatia), Pannonian woods with *Quercus pubescens* (code 91H0, Italy, Slovakia), Illyrian oak-hornbeam forests (*Erythronio-Carpinion*) (code 91L0, Croatia), Moesian silver fir forests (code 91BA, Croatia), *Quercus frainetto* woods (code 9280, Greece), *Quercus ilex* and *Quercus rotundifolia* forests (code 9340, Croatia, Italy), Acidophilous *Picea* forests of the mountain to alpine levels (*Vaccinio-Piceetea*) (code 9410, Bulgaria), (Sub)Mediterranean pine forests with endemic black pines (code 9530, Croatia).

Soil requirements: Most of the time the fungus was found on more or less basic and nutrient-rich soils, but the occurrence on distinctly acid and rather nutrient-poor soils has also been proved. Soil types: andosols (Iceland), alvar soils (Estonia), grey forest soils (Bulgaria), brown soil, podzol (Romania), ranker, vega. Geologic substrate: e.g. granite, limestone. Grain size: from sand to clay. Litter layer: absent to rather thick. The fungus only avoids very wet and peaty soils.

Synanthropy: The species occurs in natural, semi-natural as well as in strongly anthropogenic habitats (e.g. cemeteries and gardens).

Indicator value: At the European scale the fungus should be considered as euryoecious and without a clear indicator value, even if, regionally, it can be an indicator of specific habitats and ecological conditions.

Occurrence of fruitbodies (phenology)

In temperate regions, the ascocarps are produced from early summer till late autumn (May–November). In the Mediterranean region, the period of fructification is extended (e.g. in Spain from January till December).

Frequency

Number of currently known sites: About 500.

Changes in frequency: In Estonia, a decrease has been noticed for the last 3 decades. In Austria, Czech Republic, Finland, France, Greece, Iceland and Spain, no changes of frequency have been observed.

Threats and conservation

Threats: E.g. silvicultural intensification would reduce the number of sites.

Status of conservation: The species is red listed in Austria, Belgium (regional red list), Bulgaria, France, Germany, Hungary, Netherlands, Poland and Spain (regional red list).

Thuemenidium atropurpureum (Batsch: Fr.) Kuntze

Ascomycota, Geoglossales, Geoglossaceae

Synonyms: *Geoglossum atropurpureum* (Batsch: Fr.) Pers., *Microglossum atropurpureum* (Batsch: Fr.) P. Karst., *Corynetes atropurpureus* (Batsch: Fr.) E.J. Durand, *Microglossum robustum* (E.J. Durand) Ramsb. & A.L. Sm.

Note 1: The basionym of this species is *Clavaria atro-purpurea* Batsch, *Elenchus fungorum* (1783). Persoon made the combination in *Geoglossum* in the second volume of the *Observationes mycologicae* (1799).

Note 2: Schoch et al. (2009) demonstrated that the genus *Thuemenidium* (including *T. atropurpureum*) is close to the genera *Leotia* and *Microglossum* and well separated from the genera *Geoglossum* and *Trichoglossum*. Hustad et al. (2013) also concluded that it is close to *Microglossum*.

Note 3: *Geoglossum arenarium* (Rostr.) Lloyd [*Thuemenidium arenarium* (Rostr.) Korf = *Sabuloglossum arenarium* (Rostr.) Hustad et al.] is considered as a synonym of *T. atropurpureum* by some authors but, after recent studies (Ohenoja et al. 2010, Hustad et al. 2013), it is a well distinct species, closer to the genera *Geoglossum* and *Trichoglossum*.

Brief description

A dark purple brown earth tongue mostly present in the Atlantic, Boreal and Central-European domains. It is a terricolous saprotroph often colonizing mossy and grassy soils in extensively used meadows and pastures. The species is mainly threatened by intensification of grassland management and by eutrophication.

Geography

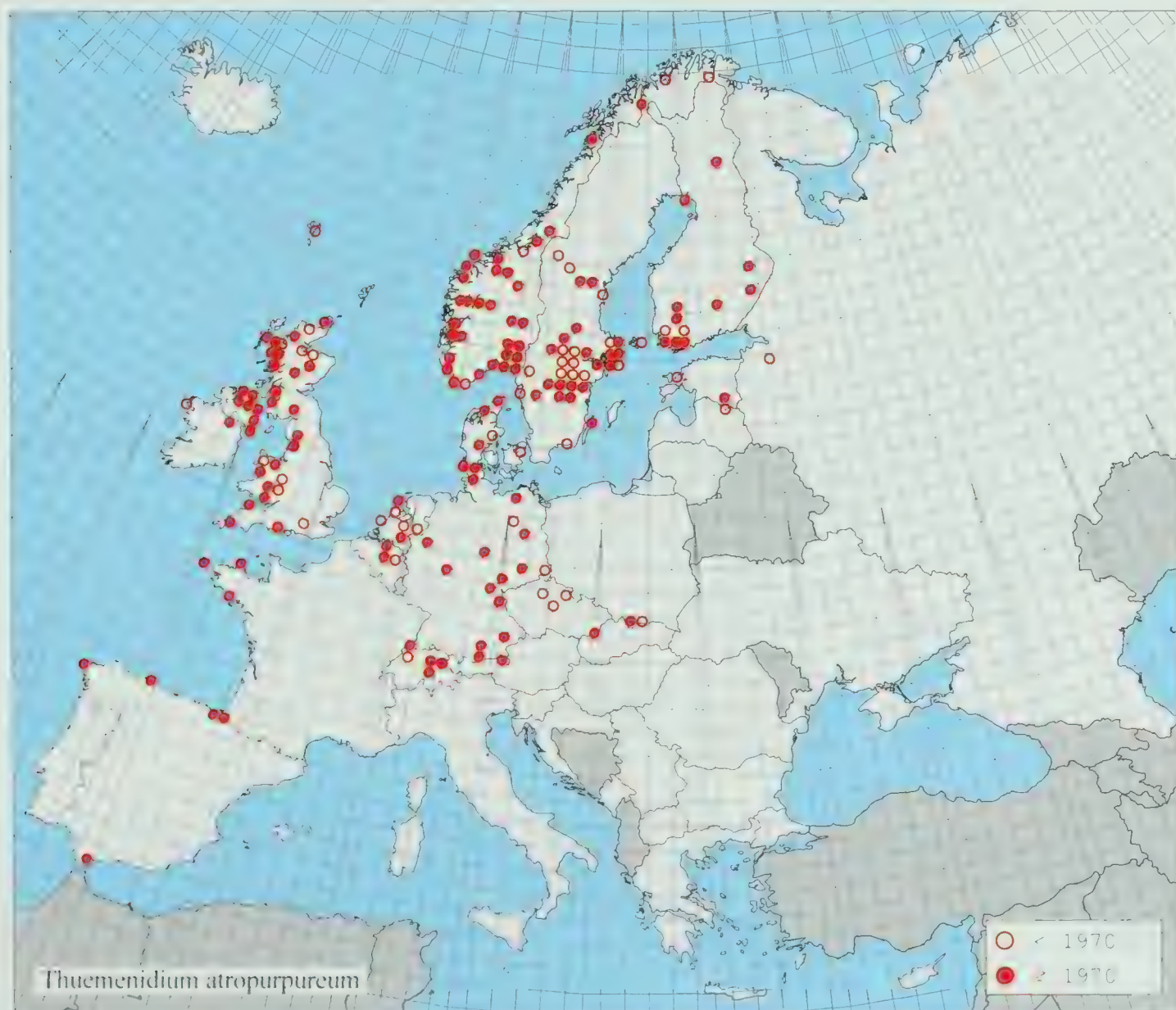
Global distribution: Europe, Asia (India, Japan), Africa (Canary Islands), North America (Canada, USA, Mexico).



Thuemenidium atropurpureum



Photo by Jean-Pierre Deschamps



Bibliography: Imai (1941), Seaver (1951), Mains (1955), Thind & Singh (1970), Baral & Krieglsteiner (1985), Nauta & Vellinga (1995), Medel & Calonge (2004), Fraiture & Walley (2005), Chmiel (2006), Kučera et al. (2008), Galán et al. (2009).

Distribution in Europe: The species exclusively occurs in the lowlands (up to 500 m). Besides localities indicated on the map, the species is also present in Poland (fide Chmiel 2006).

Areal diagnosis for Europe: Mainly Bor., Atl. and C-Eur.; also in Sarm. (NW) and Alp.; very rare in Arct. and Medit. (one record in S Spain); absent from Therm. and Step.

Trophism, hosts and substrates

The species is a terricolous saprotroph often colonizing mossy and grassy soils.

Habitat

Vegetation: The fungus mainly inhabits extensively used meadows and pastures, but it has also been found in coastal grasslands and dunes (e.g. UK), on mossy banks and in clearcut areas (Germany). In Spain, the occurrence in evergreen *Quercus* forests is reported and, in France, in shrub vegetation (e.g. *Buxus* stands). In Finland the species was found in forests with grasses and herbs, in Netherlands in deciduous forests.

Syntaxa of vegetation: FORESTS: *Prunetalia* (especially *Buxus* stands), *Calluno-Ulicetea minoris* (both France), *Asperulo-Fagetum*, *Tilio-Acerion* (both Switzerland), *Carpinion betuli* (Slovakia); GRASSLANDS: *Anthyllidi-Trifolietum montani* (Poland), *Galio saxatilis-Festucion filiformis* (France), *Nardetea strictae* (France, Slovakia, Switzerland), *Brachypodio pinnati-Molinietum arundinaceae*, *Bromion erecti*, *Festuco-Brometea*, *Arrhenatherion*, *Scheuzerio-Caricetea fuscae*, *Caricion davallianae* (all Slovakia).

Natura 2000 habitats: Fixed coastal dunes with herbaceous vegetation (grey dunes) (code 2130, Denmark, Germany, Netherlands, UK), Dry sand heaths with *Calluna* and *Genista* (code 2310, Germany, Netherlands), European dry heaths (code 4030, France), Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (code 6210, Denmark, Estonia, Finland, Netherlands, Slovakia, Sweden), Species-rich *Nardus* grasslands on siliceous substrates in mountain areas (and submountain areas, in Continental Europe) (code 6230, Denmark, Finland, France, Slovakia, Sweden, Switzerland, UK), *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) (code 6410, UK), Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) (code 6510, Slovakia, Sweden), Mountain hay meadows (code 6520, Poland), Fennoscandian wooded meadows (code 6530, Finland, Sweden), Semi-natural tall herb humid meadows (code 7210, UK), Alkaline fens (code 7230, Slovakia), *Asperulo-Fagetum* beech forests (code 9130, Switzerland), *Tilio-Acerion* forests of slopes, screes and ravines (code 9180, Switzerland), *Quercus suber* forests (code 9330, Spain).

Soil requirements: The fungus inhabits dry, fresh as well as rather wet soils (grain size sandy to clayey). The pH varies from basic to acid, the nitrogen content is always low (types brown soil, calcareous soil, podzol). The litter layer is absent or thin.

Synanthropy: The species is restricted to near-natural (e.g. dunes, forests) and semi-natural habitats (e.g. grasslands).

Indicator value: The species indicates more or less open and nitrogen-poor sites.

Occurrence of fruitbodies (phenology)

Ascocarps are mainly produced from summer till autumn (July-October); in France and UK still in December.

Frequency

Number of currently known sites: About 150 (nearly 50 % of which in Sweden).

Changes in frequency: There is no record from Russia after 1902. In Denmark a decrease has been noticed during the last 3 decades, in Sweden during the last 6 decades. In Finland and France no changes of frequency were announced. In UK an increase in the number of sites is reported.

Threats and conservation

Threats: The sites are mainly threatened by intensification of use and by eutrophication.

Status of conservation: The species is red listed in Belgium (regional red list), Denmark, Finland, France, Germany, Iberian Peninsula (Spain + Portugal), Netherlands, Norway, Poland, Sweden and Switzerland. See also Dahlberg & Croneborg (2003, 2006).

Poronia erici Lohmeyer & Benkert

Ascomycota, Xylariales, Xylariaceae

Note 1: Because the species was described only in 1988, no older data exist in the literature and the former distribution of this fungus is widely unknown.

Note 2: The species can be distinguished from *P. punctata* (also treated in this work) by the larger spores, the usually smaller ascocarps and the substrate, which often consists in droppings of rabbit or hare (Doveri 2004, Lohmeyer & Benkert 1988).

Brief description

A pyrenomycete close to *P. punctata* (see notes above). The ascocarps are composed of a whitish grey then blackening stem, carrying a beige disc dotted by the black perithecia. The species is mostly present along the coasts of the North and the Baltic seas, within the Atlantic and Central-European domains. It is a coprophilic species, fruiting on the dung of herbivores, especially rabbit. It occurs in nutrient-poor grasslands, mainly in coastal dunes. Ascocarps are produced from the second half of autumn to spring.

Geography

Global distribution: Europe, America (Mexico), Oceania (Australia, Tasmania).

Bibliography: See a.o. Lundqvist (1989), Lohmeyer (1994) and San Martin et al. (1998).



Poronia erici

Photo Ruben Walley

Distribution in Europe: The fungus has been only observed in the lowlands.

For the distribution in Europe, see also Lohmeyer & Benkert (1988, with possible observation in UK), Jalink (1992), Schavey J. (1994), Cacialli et al. (2000), Laessoe (2000), Doveri (2004), Fraiture & Walley (2005), Spooner (2011).

The point in Spain has been added after the map published by Lohmeyer (1994) and its position on the map presented here is somewhat approximate.

Areal diagnosis for Europe: Mainly Atl. (almost exclusively along the coasts of Belgium, Netherlands and Germany), also C-Eur. (mainly along the Baltic Sea); very rare in Medit.; absent from the other domains.

Trophism, hosts and substrates

The fungus is a coprophilous saprotroph colonising dung of herbivores, mainly of rabbit, but also of hare (Denmark), horse (France, Netherlands), cattle (Italy, see Doveri 2004), cow, goat and sheep. See also Lundqvist (1989) and Doveri (2004).

Habitat

Vegetation: The species occurs in nutrient-poor grasslands, e.g. in unimproved pastures. It has been repeatedly found in coastal grey dunes but also in inland regions.



Syntaxa of vegetation: DUNES: *Ammophilion arenariae* (Germany), FORESTS: *Quercetum trojanae* (Montenegro).

Natura 2000 habitats: Pannonic salt steppes and salt marshes (code 1530, Austria), Fixed coastal dunes with herbaceous vegetation (grey dunes) (code 2130, Denmark, Germany, Netherlands).

Soil requirements: Since the species is coprophilous, soil characters should not be of great importance. Colonized droppings were mainly found on sandy and rather dry soils.

Synanthropy: The species is limited to natural and semi-natural grasslands.

Indicator value: The species probably indicates natural and semi-natural open biotopes, not artificially fertilized and not polluted by pesticides and emissions.

Occurrence of fruitbodies (phenology)

Stromata are produced in periods of high moisture and humidity, from late autumn to spring (October-May).

Frequency

Number of currently known sites: About 25, but the species is perhaps overlooked.

Changes in frequency: In France an increase of sites is reported for the last 10 years, in the Netherlands for the last 20 years.

Threats and conservation

Threats: Localities outside dunes are threatened by agricultural intensification (e.g. by fertilizers and pesticides).

Status of conservation: The species is red listed in Belgium (regional red list), France, Germany and UK.

Poronia punctata (L.: Fr.) Fr.

Ascomycota, Xylariales, Xylariaceae

Note 1: Data for *Poronia punctata* published before 1988 can include records of *Poronia erici*.

Note 2: The anamorphic state, which is also coprophilic, has been described by Stiers et al. (1973). See also Huth & Huth (2014).

Brief description

A pyrenomycete close to *P. erici* (see notes under that species). The ascocarps are composed of a whitish grey, blackening stem, carrying a beige disc dotted by the black perithecia. It is rather widely distributed in Europe but almost absent from the Boreal domain. It is a coprophilic species, growing on the dung of herbivores, especially of horse and donkey. It occurs in rather nutrient-poor grasslands, such as dry pastures and dunes, especially in places where vegetation is short. Ascocarps can be produced throughout the year, when humidity is sufficient. The species seems to have declined in many regions

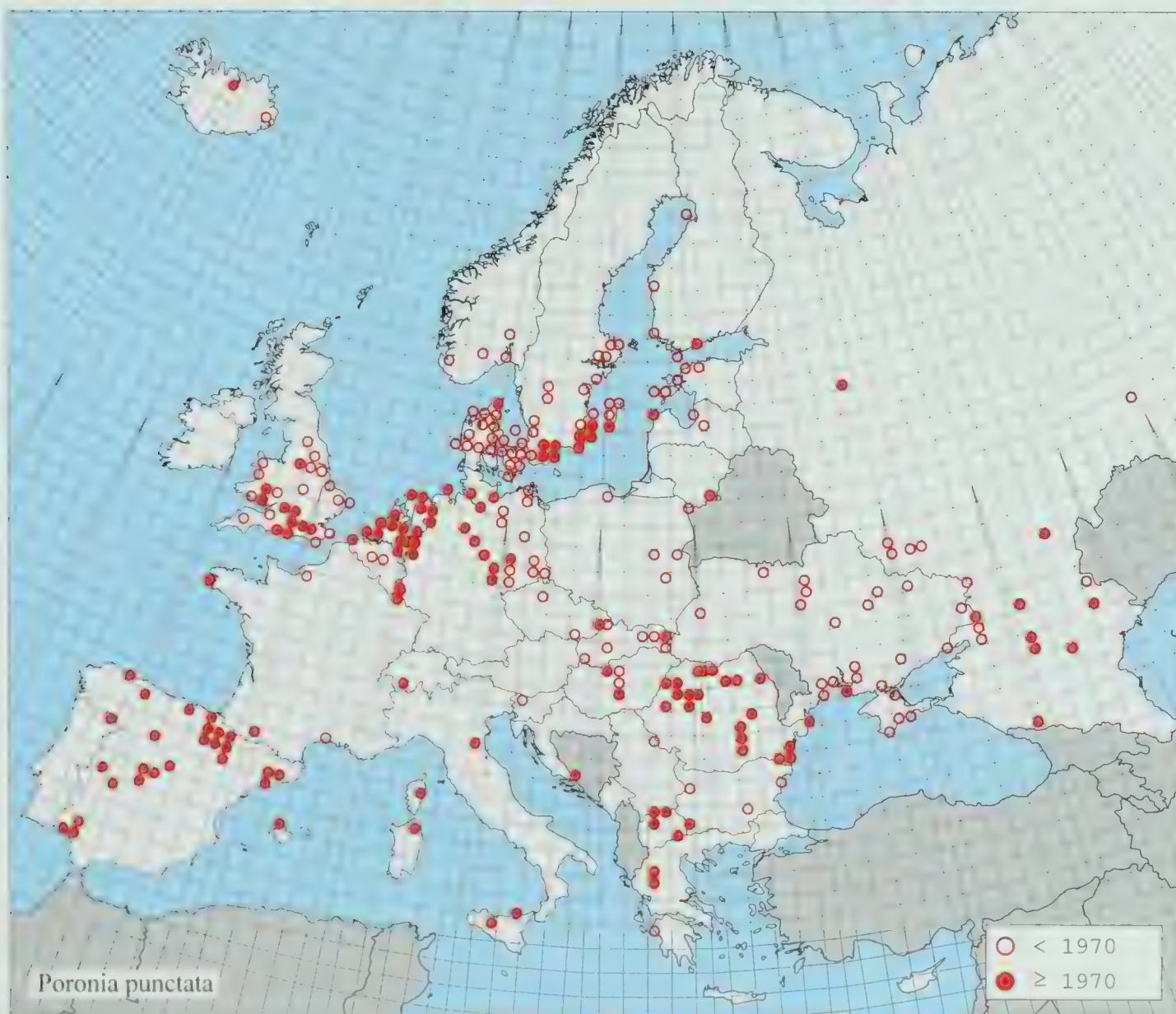
Geography

Global distribution: Europe, Asia (Georgia, Siberia, central Asia: e.g. Kirgizia, Mongolia, India?, China), Africa (South Africa), North America (USA, Mexico), Central America (Costa Rica, Puerto Rico) and South America (Argentina, Venezuela).



Poronia punctata

Photo Jean-Paul Maurice



Bibliography: Doidge (1950), Butler & Bisby (1960), Dennis (1970), Pérez-Silva (1970), Lohmeyer & Benkert (1988), Teng (1996), Matocek (2000), Cantrell et al. (2012), Gvritishvili et al. (2012), Iturriaga & Minter (2012).

Distribution in Europe: The species occurs from the lowlands to mountainous regions (in Romania also above 1200 m). See also Lohmeyer & Benkert (1988), Fraiture & Walley (2005), Bresinsky & Dörfelt (2008).

Areal diagnosis for Europe: Mainly Sarm. (mostly old records), Atl., C-Eur., Therm., Medit. and Step. (mostly old records); very rare in Arct. (Iceland), Bor. (an old record in Finland) and Alp.

Trophism, hosts and substrates

It is a saprotrophic coprophilous species colonising dung of herbivores, mainly of horse and donkey, less often of cow (historical records for Czech Republic and Germany, furthermore Russia, Ukraine), exceptionally of hare and sheep (Germany, Netherlands). In the past, it has also been recorded on dung of mule in Croatia (Matocek 2000). See also Doveri (2004).

Habitat

Vegetation: The fungus has always been found in grazed habitats more or less poor in nu-

trients, often in dry pastures, e.g. alvar meadows (Estonia), in dune areas (Finland), karstic rockfield grasslands (Croatia), in steppes (Hungary, Ukraine, Russia), but also in heaths and open woodlands (UK). It is also reported for pasturages within settlements (Ukraine, Russia). Cox & Pickess (1999) underline that it occurs on dung in predominantly short vegetation. In Sicily, it seems that the type of agricultural practices does not influence the presence of the fungus, which is also rare in traditionally managed sites (Venturella & Saitta 2009).

Syntaxa of vegetation: GRASSLANDS: *Festuco-Brometea* (Germany), *Festucetum sulcatae*, *Festuceto rubrae-Agrostidetum* (both Romania).

Natura 2000 habitats: Fixed coastal dunes with herbaceous vegetation (grey dunes) (code 2130, Denmark, Netherlands), Atlantic decalcified fixed dunes (*Calluno-Ulicetea*) (code 2150, Netherlands), Dry sand heaths with *Calluna* and *Genista* (code 2310, Netherlands), Inland dunes with open *Corynephorus* and *Agrostis* grasslands (code 2330, Lithuania), European dry heaths (code 4030, Netherlands), Subcontinental peri-Pannonic scrub (code 40A0, Hungary), Alpine and subalpine calcareous grasslands (code 6170, Ukraine), Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (code 6210, Estonia, Finland, Germany, Sweden), Sub-Pannonic steppic grasslands (code 6240, Hungary, Ukraine), Pannonic sand steppes (code 6260, Hungary), Ponto-Sarmatic steppes (code 62C0, Ukraine), *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) (code 6410, Ukraine), Lowland hay meadows (*Cladocarpus pratensis*, *Sanguisorba officinalis*) (code 6510, Czech Republic, Ukraine), Mountain hay meadows (code 6520, Macedonia), Calcareous rocky slopes with chasmophytic vegetation (code 8210, Croatia), Eastern white oak woods (code 91AA, Greece), Pannonic inland sand dune thicket (91N0, Serbia), Moesian beech forests (code 91W0, Greece).

Soil requirements: Since the species is coprophilous, soil characters should not be of great importance. Colonized dung was found on e.g. regosol, rendzina, brown soil, (Romania), grey forests soil and leached cernoziomic soil (both Bulgaria). In northern areas the fungus prefers rather dry and warm soils (e.g. in Iceland only in the driest part of the island, in Sweden in thermophilic sites).

Synanthropy: The species occurs in different kinds of grassy habitats, from natural to anthropogenic.

Indicator value: Possibly the fungus is limited to grasslands not artificially fertilized and not polluted by pesticides and emissions.

Occurrence of fruitbodies (phenology)

Because the species often colonizes bigger dimensioned dung with a good water storage the stromata are also produced in periods with higher temperature, mainly from spring and summer till late autumn (April-November); in France, Germany, Macedonia, Netherlands and UK, it has also been found in winter.

Frequency

Number of currently known sites: About 100 (nearly 90 % of which in Spain, Sweden and UK).

Changes in frequency: In Estonia there is no record after 1960, for Poland after 1915, for Russia after 1959 and for Slovakia after 1982. In Denmark, Finland, France, Germany, Russia, Slovakia and Sweden a decrease has been reported for about 100 years, in Iceland and Spain for the last 3-5 decades, and in Netherlands a decrease within the period 1970-1990 but afterwards an increase. In Latvia no changes have been noticed. In Belgium, the



Poronia punctata

Photo Jean-Paul Maurice

re-introduction of large herbivores (a.o. Galloway cattle) for the management of natural sites resulted in a progression of the species (Fraiture & Walley 2005). After Whalley & Dickson (1986), the decline observed in the UK is due to the fact that the number of ponies has been reduced; also, horses and ponies diet is now supplemented with various types of fodder and additives. In the New Forest (southern England), where *Poronia punctata* is still present, horses are living in the “wild” and forage freely. In the southern part of Russia, an increase of sites is reported for the last 5 years, obviously due to an increase of field research in steppic areas, where this species seems to be quite common. See also Lohmeyer & Benkert (1988).

Threats and conservation

Threats: The sites are threatened by agricultural intensification (e.g. by using fertilizers and pesticides) producing a loss of unimproved grasslands. The decline in use of horses and the reduction of grazing periods (at sites with stable fungal populations the animals are grazing all over the year) are other possible threats. See also Senn-Irlet (1994) and Granito & Lunghini (2006).

Status of conservation: The species is red listed in Belgium (regional red list), Bulgaria, Denmark, Estonia, Finland, France, Germany, Hungary (Koszka 2008), Macedonia, Netherlands, Norway, Poland, Slovakia, Spain (regional red list), Sweden, Switzerland and UK. The species is included in the IUCN *Global Fungal Red List Initiative* (see their web-site).

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The ECCF Mapping Programme has been launched with the aim of drawing the distribution map of 51 species of macrofungi in Europe and of gathering information on the ecology and status of these species in the different countries. The publication of this book is the culmination of several years of work and is the result of the collaboration of almost 300 mycologists, in 38 European countries.



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